MAY 26 1934

Engineering News-Record

May 24, 1934

Think Back a Few Weeks . . .

. . . ANYONE prone to be pessimistic about technical progress need only think back a short time. The road we have come was never more plainly marked with the results of active new thinking. Whatever reason there may be for concern as to some things, there can be none as to technical initiative or accomplishment.

. . . TO RECALL a few specific instances: The pages of this journal have recorded within recent weeks notable progress in the application of vibration to concrete pavements, in the utilization of equipment for eliminating rock-drilling silicosis, in the improvement of design and construction practices to cope with earthquake forces. Last week a new quantitative study of building frames was reported. And in the present issue begins a series of articles telling of significant research into the possibilities of stabilized earth roads. Soon the highly original creation of new revetment types on the Mississippi will be described.

. . . WITHIN THE SIX MONTHS, pumping as a medium of concrete distribution has emerged as a practical improvement applied extensively to buildings, dams, bridges and locks. Cement-macadam roads have been resurrected from the dead and adapted to modern traffic. The science of soil action in all its complexities has been applied through model tests to the design of a remarkable retaining wall of gravity type. In these instances and many others technical achievement of high order is readily recognized.

. . . CHARACTERISTIC of these advances is the part played by the manufacturers of equipment and materials. And in thinking back, let us bear in mind that these organizations have made their contributions not in superficial claims but in careful research and cooperative action with engineers and constructors alike. With the whole industry working together thus progressively, it is clear that there is no ground for a doubtful attitude concerning the virility of technical achievement.

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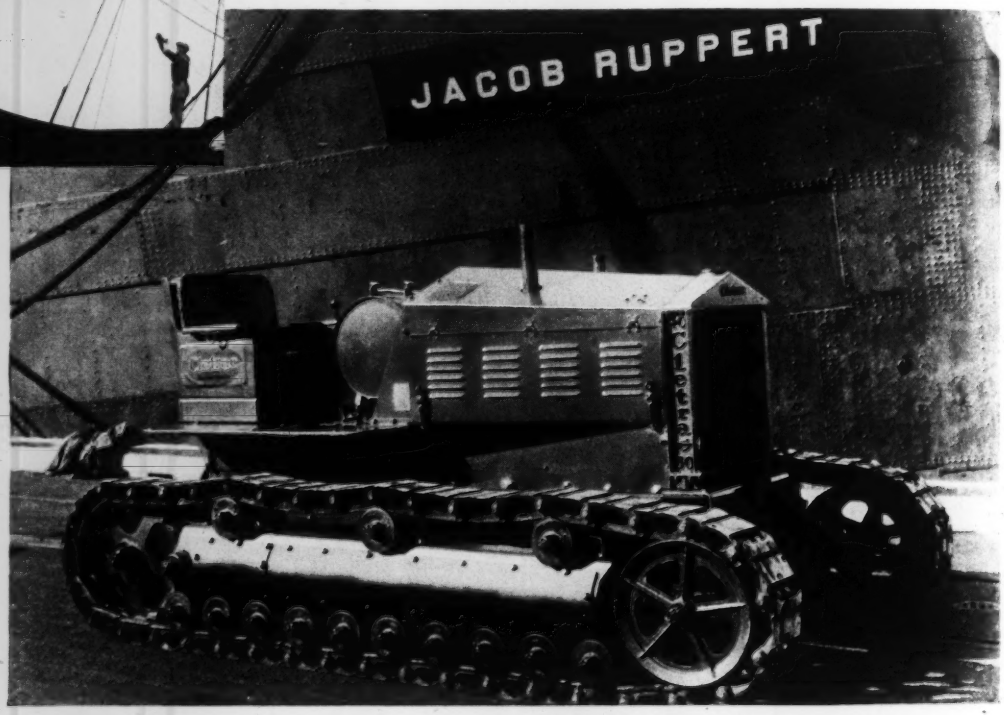
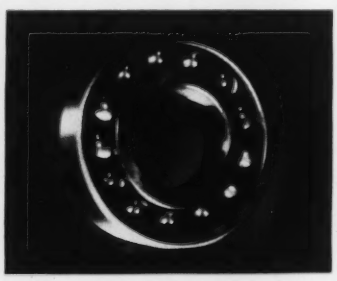
With Admiral Byrd in Little America



CLETRAC

SOMEWHERE near the South Pole, Admiral Byrd's men are busy . . . preparing for five months of darkness. But the papers tell us that mild weather is with them . . . 32 degrees below zero, Fahrenheit. Brr-r-r!

All the heavy hauling jobs around this cozy summer resort are taken care of by a Cletrac tractor. Inside this tractor are numerous New Departures . . . bearings that can look an icicle straight in the face and keep on working efficiently.



The ball bearing is so nearly perfect in theory and practice that it runs with ease where others "fear to tread." Byrd knows his bearings and so do the thousands of buyers of construction machines who specify New Departures.

And in the blistering heat at Boulder Dam, in hundreds of tractors and trucks, New Departures are again proving that they have the stuff of which endurance is made. » » » The New Departure Mfg. Co., Bristol, Conn.; Detroit, Chicago and San Francisco.

NEW DEPARTURE

ENGINEERING NEWS-RECORD

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CONTENTS FOR MAY 24, 1934

VOLUME 112 NUMBER 21 COPYRIGHT, 1934

Developing the Greater Port of Havre—I.....651
BY E. E. R. TRATMAN

Ithaca CWA Converts Swamp Into Park.....655
BY HARRY W. EUSTANCE

Bridge-Building Practices in the U.S.S.R......657
BY C. L. CHRISTENSEN

Stabilized Soil-Bound Road Surfaces—I.....660
BY W. R. COLLINGS and L. C. STEWART

Beam Deflections by Trigonometric Series....664
BY A. A. JAKKULA

Research Notes—Ohio State University.....666

Wrought-Iron Fire-Stops Below Pier Decks..668

Laws and Ordinances for Highway Safety....669

Review of Engineering Literature.....671

Letters to the Editor.....672

Editorials.....674

Current News.....676

In the News:

ANNOUNCEMENTS of new parks or major improvements in existing parks have been almost daily items of news in New York since the new park administration took office. Most recent is the plan to utilize the 400 acres of Randall's and Ward's Islands in the East River (under the new Triborough Bridge) for a new recreation center. Old hospitals and institutions on the islands are being evacuated and razed.

THE FAMOUS NATIONAL THEATER in Mexico City, now known as the National Palace of Fine Arts, has been completed just 30 years after it was begun. Since 1910 its uncompleted framework has been a prominent landmark in Mexico City's Central Park. With political and financial troubles finally overcome, the building is now ready for use by the Ministry of Education.

NEW YORK CITY, with $23,160,000 of the PWA funds it obtained last week, will equip the uncompleted part of its new subway (some 60 track-miles) with rails, signals, etc. Another million dollars will be used for valves and other equipment in the new water tunnel, and $4,000,000 will be used for incinerators. The remainder, some $10,000,000, goes to schools and hospitals.

THE LOCATIONS of four more dams, in addition to Norris and General Joe Wheeler Dams, which are now under construction, are announced by the TVA. Two of the proposed new structures are on the lower Tennessee, and two are on tributaries, primarily for storage.

ST. LOUIS provided for continuing work on its great Memorial Plaza development by voting $1,900,000 for the Soldiers Memorial Building in the bond election last week. Plans are yet to be drawn. The new municipal auditorium, recently opened, represents the most recent addition to the plaza development.

CONSTRUCTION CODE HEARINGS were resumed this week, NRA considering the proposals of the building contractors, highway contractors and heavy construction and railroad contractors to establish specialist subchapters of Chapter II, the general contractors' code.

In This Issue:

HAVRE, FRANCE, famous as an ocean port since early in the sixteenth century, has been progressively improved and enlarged during the intervening years. Comprehensive modernization is now under way, involving bold open-sea structures, new docks, basins and passenger and freight-handling facilities. The features of this great seaport are given in an article in this issue, to be followed soon by an article on the design and construction of the major port structures.

ITHACA, N. Y., concentrated its CWA expenditures on a single project, a lake-front park, located on the site of an old swamp. As a result, 300 workers had jobs on a project planned for the use of themselves and their families. Morale and efficiency were therefore high. A long-deferred civic improvement is materializing.

RUSSIA'S engineering efforts are interesting because they are pioneer efforts. In a measure the U.S.S.R. is re-enacting the empire-building days of the 80's in this country. Where steel is scarce, knowledge of concrete limited and timber plentiful bridge-building practices tend to concentrate on timber structures, and do so, except that many rivers are wide and deep. How Russia is meeting the problem is told by an American bridge engineer who has spent three years advising the Russians on modern technique.

THE FIRST ARTICLE in a series on soil stabilization introduces the subject by a discussion of the basic theories, with consideration of soil properties and the function of calcium chloride, which is to insure moisture for soil-particle cohesion in dry weather.

RESEARCH at the engineering experiment station of Ohio State University is unusually varied. At present, important investigations concern soil characteristics in relation to road subgrades, concrete workability, heated aggregates, wind design of steel frames and pile foundations.

MODEL LAWS AND CODES for motor vehicle operation were approved at the meeting this week of the National Conference on Street and Highway Safety. Among the subjects covered are registration, traffic-regulation practice, financial responsibility and traffic-control devices.

Coming Articles:

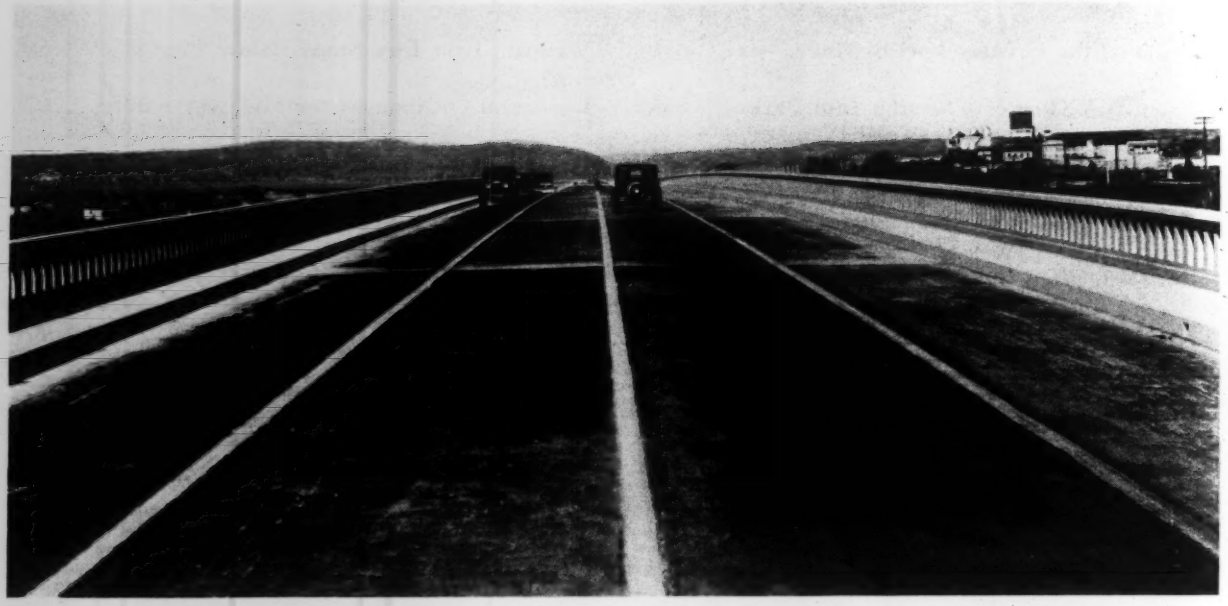
NEXT WEEK'S ISSUE will be the annual waterworks number, published, as in the past, just prior to the meeting of the American Water Works Association. Nine articles will present: (1) specific water-service improvements in a period of national emergency; (2) plans for future improvements in four different regions; and (3) water revenue problems during the depression.

White Concrete Traffic Markers

STAY WHITE

Because They Are

BUILT WHITE



Atlas White traffic markers on the San Diego River Bridge, San Diego, Calif. B. O. Larson, San Diego, was the contractor.

A white concrete traffic marker is *built into* the pavement, *not* on top of it. Into a recess in the pavement, white concrete made with white aggregate and white portland cement is placed. Before the white concrete takes its set, it is troweled to a smooth, dense, impenetrable surface. Then, when it has cured, a *permanent* traffic marker is ready for service—*years* of service—years of *cost-free* service.

Such a marker is placed easily and quickly into any type of pavement, old or new. Neither specially trained labor nor costly equipment is needed.

This kind of white marker *stays* white. Its surface resists staining. Each rain washes it clean of surface dirt.

Built of concrete, an integral part of the pavement, permanently white, such a marker naturally requires no maintenance. It thus actually pays for itself in replacement cost savings. And its original cost is not high. Write for complete information to Universal Atlas Cement Co., *Subsidiary of United States Steel Corporation*, 208 South La Salle Street, Chicago.

175

ATLAS WHITE TRAFFIC MARKERS

MADE WITH ATLAS WHITE PORTLAND CEMENT—PLAIN OR WATERPROOFED

ENGINEERING NEWS-RECORD

New York

May 24, 1934

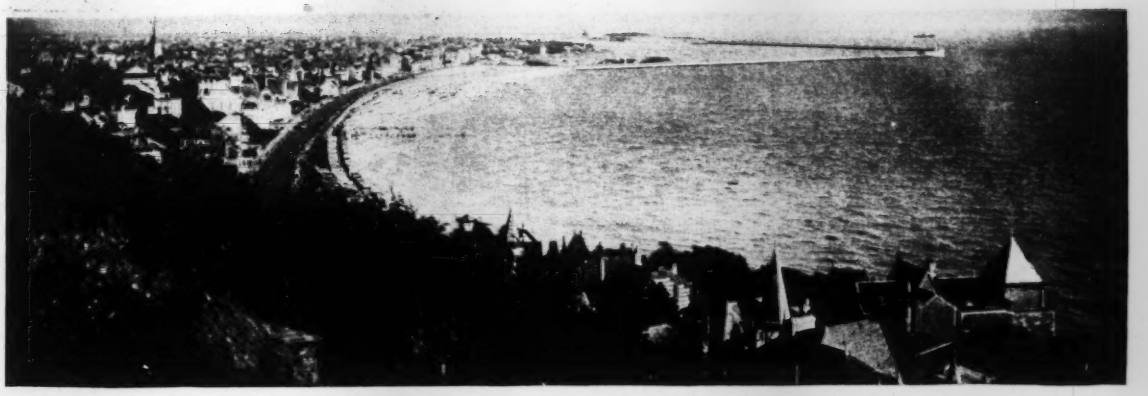


FIG. 1—PORT OF HAVRE, facing open sea, is approached between two breakwaters and includes vast assemblage of inland docks, terminals and industrial developments.

Developing the Greater Port of Havre

Comprehensive modernization works at famous French port involve bold open-sea structures and extensive provision for marine traffic and industrial development

By E. E. R. Tratman
Wheaton, Ill.

EXTENSIONS undertaken and contemplated at the French port of Havre are creating one of the most complete commercial and industrial harbor developments of the present century. As planned, the improved harbor will provide facilities for the largest ocean liners, for the foreign and colonial shipping traffic, for the rapidly increasing oil traffic, for rail and inland waterway connections and for local industrial development. Carried out in deep water and practically in the open sea the work has been distinguished by major problems of both engineering and construction. In this article are given, therefore, the feature elements of a great seaport plan, and a succeeding article will similarly epitomize the design and construction methods that have produced some of the boldest port structures of modern times.

The works of the port of Havre, existing and planned, are shown by Fig. 2. They are located as shown by the insert map (Fig. 2) virtually on the open coast and on beach terrain cut off inland by a coast range of hills. This topography accounts for the area secured by deep-water inclosure and by filling for made-land as shown by Fig. 2. The bed of the sea is mainly sand overlying a compact stratum of sand and gravel at 50 to 65 ft. below the water.

Port history

Successive developments of the port of Havre up to 1912, together with the deep-water extensions then projected, were described in *Engineering News*, Sept. 19, 1912, pp. 522 and 544, but the works as carried out since that time differ somewhat from the original plans.

In 1517 Havre was established officially as a naval and commercial port, having then a small tidal or open harbor protected by jetties. Cardinal Richelieu had the King's Dock built in 1628, and in 1667 its entrance was equipped with a lock. The De la Barre Dock and the Commerce Dock were completed in 1838, the Vauban Dock and Florida Dock a few years later. Then the large L-shaped Eure Dock was constructed in 1855 and the Bassin Dock in 1859. A drydock and a new entrance lock for the Eure Dock (formed by a reconstruction of the Florida Dock, and therefore named the Florida Lock), together with some minor works, were completed by 1865. To accommodate the early paddle-wheel Atlantic steamers, the new Florida Lock was made 100 ft. wide, and as the long period of high tide made only one set of gates necessary, the lock could be used by large ships, so that with occasional dredging it sufficed for more than fifty years. These works and the Citadel Dock, on the site of the old castle, were all on the low coast land, the original shore line being approximately along the line of the present Tancarville Canal (Fig. 2).

When the double-basin Bellot Dock was authorized in 1879, its submerged site had first to be inclosed by the con-

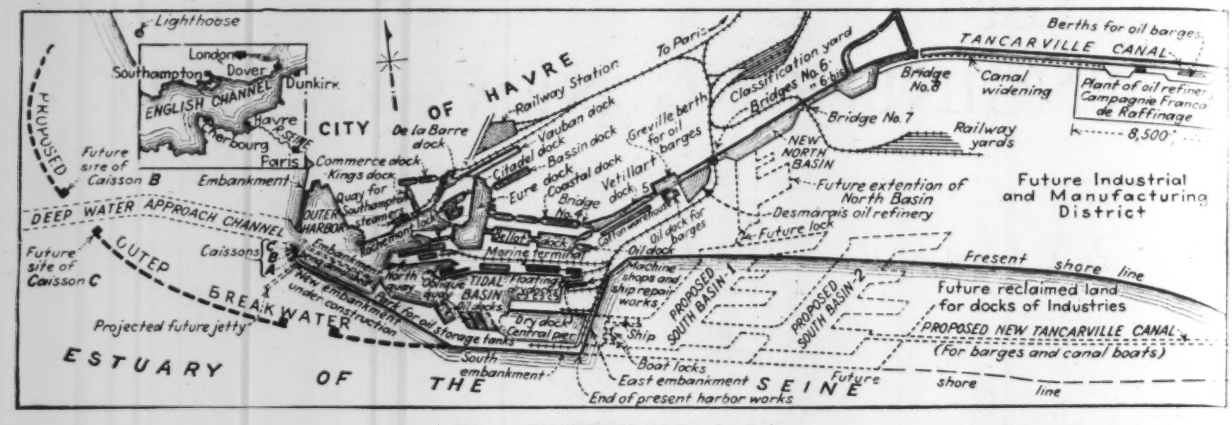


FIG. 2—PRESENT PLAN for developing and extending the Port of Havre, showing also the existing docking facilities.

struction of a long embankment, extending eastward from the south wall of the Eure Dock. The Bellot Dock (*Engineering News*, June 28, 1890, p. 602) was completed in 1890. In 1911 the old Florida Lock was replaced by the Quinnette de Rochemont Lock to permit large Atlantic steamers to enter the Eure Dock. This new lock, with two sets of gates, is 790x98½ ft., with 16½ ft. of water on the sill at low tide. Just outside its entrance is a landing quay for ships touching at the port but not wishing to enter the closed docks.

A great extension south of the Bellot Dock was authorized in 1895 to provide for the increasing size and length of transatlantic steamers. In considering the alternatives of a closed dock and an open or tidal dock, a serious objection to the former was the heavy first cost and operating cost of a huge entrance lock, with gates exposed to wave action, so that in very bad weather it might be impracticable to open the lock. For the tidal dock there was the great saving in time for steamers going directly to and from their berths at any condition of tide or weather, without the delay and manoeuvering involved in working through a lock. The tidal basin was adopted, and its plans were approved by the government in 1909.

A ship lock built in 1910 connects the Bellot Dock with the Tancarville Canal, 12 miles long, thus connecting the port with the extensive system of inland navigation by rivers and canals. This canal enables barges and small craft to pass between the port and the River Seine without crossing the open and rough water of the estuary, with its swift currents. In 1915 the west end of the canal was widened to form the Vetillart Dock, to serve an increasing industrial development, and a ship lock was built to connect it with the Bellot Dock. This lock has rolling gates that are withdrawn into recesses at right angles with the lock chamber.

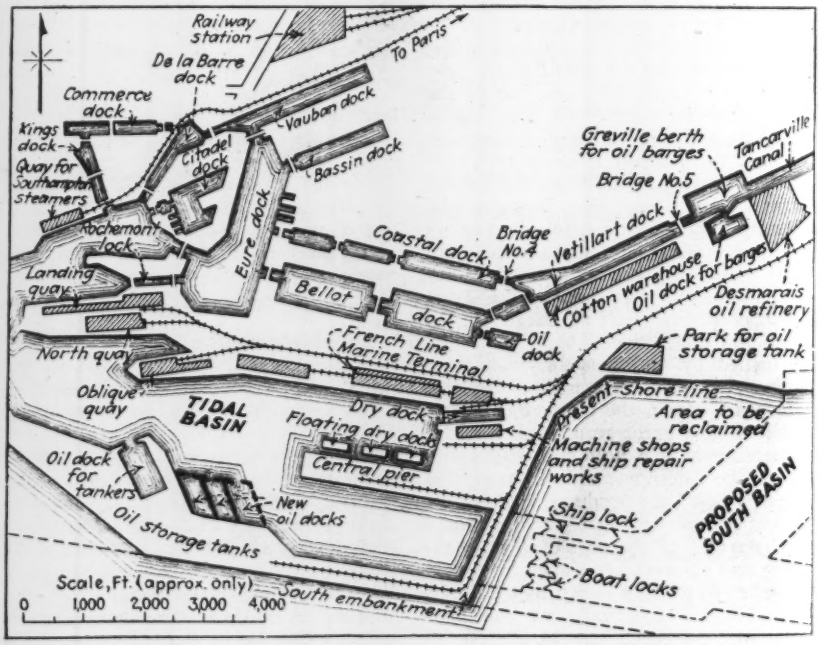
Tidal conditions

Exceptionally favorable tidal conditions constitute an important asset of the port, which is on the north side and extreme west end of the Seine estuary. The sketch or location plan, Fig. 2, shows that the south shore is concave, forming an open bay. As a result, there is a double flood tide at Havre, the main flow from the Atlantic being followed by a second flow that has passed around the south side of the bay. After the normal floodflow, therefore, the high-water level is maintained practically uniform for about three hours before the ebb flow. Thus for three hours at each high tide, or six hours daily, ships can enter the closed docks without locking. The sea-level datum of the port is at +0.30 meters (0.984 ft.), or the low-tide level. Equinoctial high tides reach 8.15 m. (26.73 ft.), and the quay level of the new works is 9.30 m., or 31 ft. above low water, or nearly 5 ft. above maximum high-tide level.

The new Tidal Basin, about 7,550x 2,460 ft., has deep-water quays accessible for the largest steamers at all times. In its design an outer harbor or outer basin was provided to allow the waves from the sea to flatten out and expend their force before reaching the inner basin in which ships are moored. For further protection the inner basin is partly separated from the outer harbor by two piers or jetties, leaving a 500-ft. entrance. However, the waves or disturbances in the outer harbor have proved to be less than had been anticipated, owing to the sea embankments that inclose the outer harbor, except at the opening for the deep-water entrance channel.

By the end of 1932 the north side of the tidal basin provided 7,870 ft. of quay, with not less than 39.36 ft. of water at lowest tides. On the south side of the basin there is a marine terminal for the petroleum trade, with deep-water

FIG. 3—RAILWAY, CANAL AND OIL-HANDLING FACILITIES indicate high development of means for interconnecting inland and ocean transport.



berths for tankers. At the east end is a large drydock.

The deep channel across the bay, for the use of large deep-draft steamers, gives a very direct approach to the outer harbor (Fig. 2), so that such vessels can proceed at considerable speed and can approach their berths without the aid of tugs. Still greater convenience will be provided by the new entrance works, described later. This channel is now 820 ft. wide and is dredged to 26.24 ft. of water at lowest tide level, and deepening to 35.40 ft. is in progress. The next step will be to widen the channel to 1,200 ft., and eventually it will be dredged to about 40 ft. of water at low tide.

The dredging equipment of the port includes three dipper dredges having 1-yd. buckets and capable of reaching to depths of 50 to 70 ft. They are served by closed and hopper barges handled by tugs. These dredges average only about 100 working days in the year on this work in open sea for a channel about 2½ miles long. During rough weather they are engaged in deepening the outer harbor and tidal basin.

Harbor entrance

A new sea embankment along the south side of the outer harbor, located about 700 ft. south of the original embankment completed in 1900, has been built to permit of widening the 575-ft. entrance. On account of the currents, which exceed 3 m.p.h. at spring tides and flow obliquely to the dredged channel, very large steamers find some difficulty in steering through the present entrance. A width of 820 ft. between the heads is considered necessary for such vessels as the new French Line super-liner "Normandie," 1,027 ft. long, which is to be in service in 1935. This widening of the basin will also increase the water area for the smoothing out of waves in rough weather, which otherwise would be aggravated by the widening of the entrance. Dispersion of the waves will be aided by a sloping and revetted surface of the harbor side on some parts of the embankment.

It was planned originally to carry the entrance widening to 1,000 ft., and to protect it by an outer breakwater forming a roadstead protected not only from the waves but also from the river currents that flow diagonally across the bay and the entrance channel. This breakwater is indicated in Fig. 2. Without such protection a very wide opening through the embankment might permit heavy storm waves to drive through the outer harbor. When financial conditions necessitated a postponement of the breakwater, the program was modified by reducing the new width of entrance to 820 ft. The first portions of the breakwater (flanking its 2,000-ft. entrance) will total 6,500 ft., to be increased eventually to about 8 miles, to form the roadstead.

Dock extensions

At the east end of the tidal basin is a drydock 1,030 ft. long, 125 ft. wide on the floor and entrance, 175 ft. wide on top and about 60 ft. deep, with 46 ft. of water over the sill at low tide. It was built in a steel floating caisson, 1,132x197 ft., which was sunk by building up the masonry floor and walls within it, the caisson landing on a bed of concrete placed by compressed air on the dredged sand and gravel formation. A steel floating gate, 131x30 ft., closes the entrance, which is also fitted with a pair of hinged dock gates. Adjacent to the drydock is the Mole Centrale, a broad pier that provides for repair and refitting work on ships moored alongside or raised on the four floating drydocks that lie near the pier and accommodate vessels of 3,700 to 16,000 tons. Extensive machine shops and other auxiliary works serve both the drydock and the refitting works.

Besides the new dock works directly accessible from the open sea, there is now under construction an interior dock, called the North Basin. This dock (Fig. 2) is formed in part by a widening of the Tancarville Canal along its south side, between bridges No. 6 and No. 7, to serve coasting vessels and small craft. Adjacent to this will be the South Basin already authorized, the construction of which is still dependent upon financial and traffic conditions. It will be formed in reclaimed land east of the tidal basin and will be connected with the latter by a ship lock 1,212x193 ft. Another but smaller lock will connect with the new North Basin. Additional basins or inclosed docks may be built east of the South Basin if the growth of the port should require them.

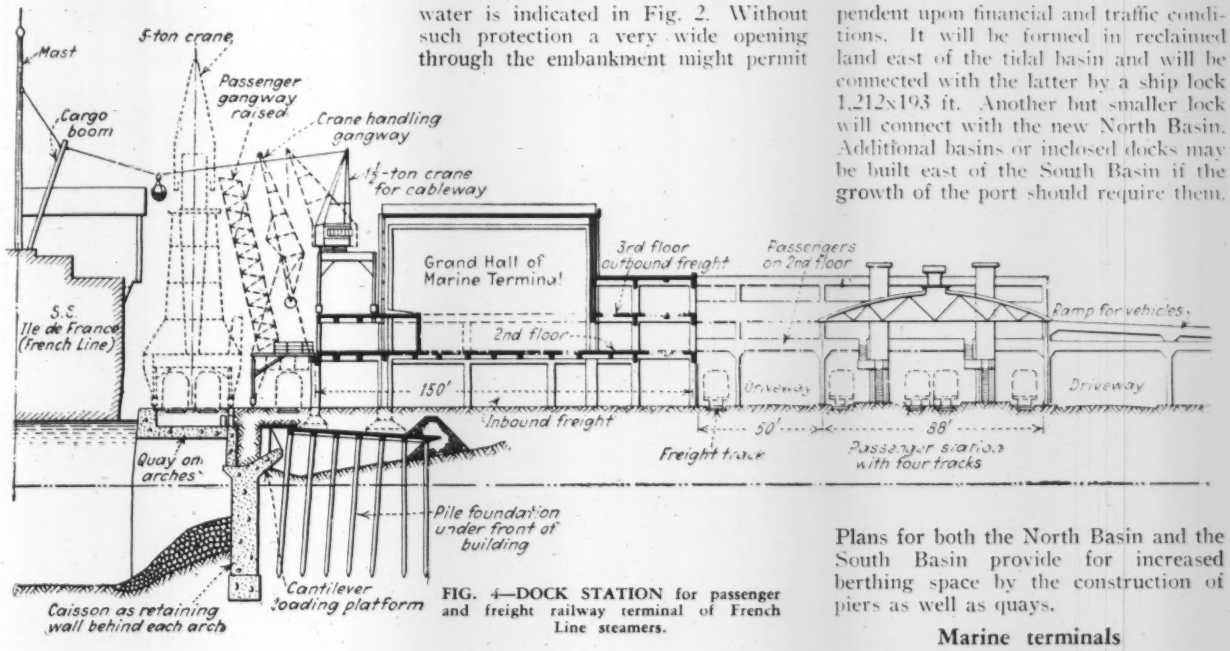


FIG. 4—DOCK STATION for passenger and freight railway terminal of French Line steamers.

Plans for both the North Basin and the South Basin provide for increased berthing space by the construction of piers as well as quays.

Marine terminals

With its numerous steamship lines to all parts of the world, Havre requires extensive facilities for the landing and embarking of passengers, and the port works include two large marine or transfer terminals to serve the Tidal Basin quays, as shown by Fig. 3.

The Compagnie Générale Transatlantique (French Line) is building a large three-story, reinforced-concrete, rail-and-water terminal building, 2,000x150 ft., for the handling of passengers and freight. This structure (Fig. 4) is already in use and will be completed in 1934. The rear part forms a trainshed covering four passenger tracks, platforms 300 ft. long and a freight track on the first floor. Escalators and stairways connect the platforms with the second floor, on which are the passenger facilities. Inbound freight is handled on the first floor, which is served by three electric overhead traveling cranes of 5 and 25 tons capacity. Outbound freight, which is in general lighter than the inbound, is handled on the third floor, wagons and motor trucks reaching this level by an inclined roadway; all passenger automobiles, inbound and outbound, are handled from

the third floor. A tower 250 ft. high serves as a mark for incoming ships.

Three railway tracks extend along the waterfront of the quay, which has also three lines of traveling gantry cranes. Semi-portal cranes running in front of the building span the first track. Each crane has a platform or gangway for passengers, accessible from second-story doorways; a long hinged extension of the gangway can be lowered to span the quay and connect with a ship's deck. In front of these cranes and spanning the two outer tracks are 5-ton portal cranes with tall towers.

A special feature is the installation of a third line of gantries, traveling on the third-floor level of the building. These are designed to operate cableways, the track cable being attached to the crane tower and to a cargo boom on the ship; on this cable runs a trolley carrying a bucket or sling. To provide for the extra load due to these roof cranes, the first two rows of columns of the building are seated on a concrete loading platform supported on piles. This construction is shown in Fig. 4, which also shows one of the caissons that serve to form a retaining wall closing the arched openings between the piers of the quay. The three lines of cranes along the quay are so arranged that the cranes can pass each other without interference and can be placed at any desired positions.

At the North Quay a two-story steel-frame terminal and transit shed, with two railroad tracks, has been built by the Compagnie Industrielle Maritime under its concession for operating a passenger and freight marine terminal. The building is about 1,100x165 ft., with a 575-ft. extension for freight, and is about 115 ft. back from the edge of the quay, which has two freight tracks. At the rear is a large open space for the storage of freight that does not need cover. Passenger accommodations are on the second floor. The crane equipment on this quay is somewhat similar to that of the French Line but without the high-level gantries upon the building. Traveling gantries with hinged extensions provide passenger gangways between ships and the second story of the terminal. Along the quay are traveling portal gantries that span two tracks; each carries a 5-ton revolving luffing crane for handling automobiles as well as baggage and cargo.

Railway facilities

Apart from the dock stations mentioned above, an important improvement is a classification yard, for separating inbound cars destined for the several quays or sheds and for assembling outbound trains (Fig. 2). A new double-track line connecting the main line into Havre with the dock stations is fenced in and has all grade crossings protected. This enables the boat trains to run to and from the docks at full speed and without entering the city station, so that the run from the steamer's side to Paris can now be made in 2 hours 50 minutes. A special facility for the daily steamer service between Havre and Southampton (England) is a track extension from the city station to the quay used by these steamers. In fitting this line, opened in 1933, to the existing works it was necessary to fill in a corner of the De la Barre Dock to carry the tracks.

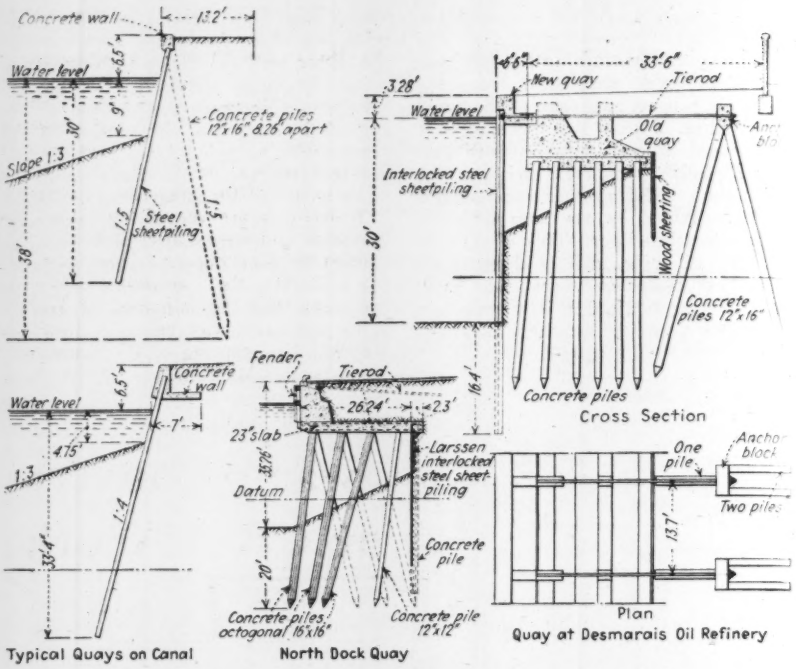


FIG. 5—QUAY-WALL TYPES for various situations along the Tancarville Canal, which connects the Port of Havre with the inland system of rivers and canals.

Canal and industrial works

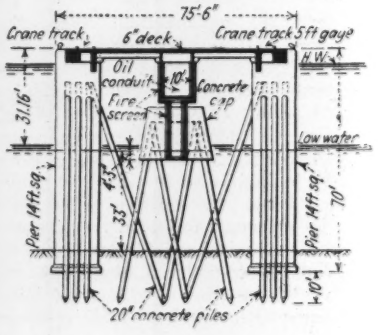
Industrial developments along the western end of the Tancarville Canal, which connects the docks with the River Seine, have necessitated extensive widening, deepening to 23 and 30 ft. and other improvements. With its new connection to the North Dock, this end of the barge canal has been converted to a ship canal, and old 52-ft. swing bridges have been replaced by 115-ft., single-leaf, rolling-lift bascule bridges. The first quay of the new basin (Fig. 5), forming also the north side of the canal, is 2,130 ft. long. Extensive reconstruction of the north bank of the canal has been carried out to permit deepening the canal and widening it to 132 ft. without affecting adjacent structures and industries. Typical works of this kind are shown in Fig. 5.

Oil docks and facilities

Special provision for oil importation and distribution has been made in view of the rapid increase in the oil traffic at Havre. On 72 acres of filled land along the south side of the tidal basin (Fig. 2), are the oil-storage works established by the Compagnie Industrielle Maritime, under a concession from the Port Authority. Importation is free, with duty paid only when the oil is removed for distribution in France. The company imported 260,000 tons of oil in 1932 but has no monopoly on importation, simply handling and storing oils for any dealers and importers.

Wet or floating docks provide for tank steamers, each dock accommodating two vessels. The first dock, 885x557 ft., with 33 ft. of water, contains two piers for mooring the tankers, each pier carrying a conduit into which the ships discharge their oil for gravity flow to the main pumping station. A newer dock, 800x262 ft., the first of three parallel docks, has its water side isolated from the tidal basin by a fire screen or curtain wall of reinforced concrete extending from 3 ft. below to 16 ft. above low water, supplemented by an upper double wall extending to 30 ft.

FIG. 6—OIL-TANKER PIERS are equipped with conduits delivering to the main oil-pumping station.



above low water. A similar fire screen separates the two berths in each deck. The two mooring piers are shown by Fig. 6.

The open ends of the oil docks are closed normally by floating barriers to prevent the escape of oil (especially flaming oil) into the main basin in case of accidents in unloading. The barrier consists of a row of steel pontoons 5 ft. in diameter, each with a ballast box 18 in. square along the bottom and a walkway along the top. These pontoons are about 100 ft. long, with square ends overlapping side by side and fastened together with wire-rope lashings on mooring posts. At each end of the barrier is a pontoon 6½ ft. square and about 16 ft. long, with a pointed end that slides in a vertical groove in the concrete entrance wall as the tide rises and falls. Flexible sliding pieces prevent the escape of oil around these guides.

On the filled area there are about 50 oil-storage tanks with an aggregate capacity of some 350,000 tons. A smaller group or park of tanks is installed east of the Bellot Dock, while at the Central Pier there are facilities for barreling oil and also for delivering it to tank wagons and railway tank cars. There are separate facilities to be noted later, for the delivery of oil to barges and canal boats, but all the oil facilities are connected by pipe lines.

Industrial development

It is proposed by the Port Authority to form a site for an industrial district by filling in the low alluvial lands between the Seine and the Tancarville Canal, as industries using raw materials imported by sea will find such a location very favorable. As further inducement, the Tancarville Canal is to be converted into a maritime and industrial waterway, or an elongated dock serving the industries. Since it will then have little facility for barge traffic, a new barge canal is projected along the south side of this district.

Port administration

Management of the port is in the hands of the Port Autonome du Havre, an autonomous council or commission composed of 21 members: nine represent the Chamber of Commerce of Havre; one each for the chambers of commerce of Paris, Rouen and Bolbec; three for the principal steamship companies. The other six members represent, respectively, the French government (Ministry of Finance), the local department (Seine Inferieure), the State Railways, the Eastern Railway, the city of Havre and the local labor interests. This council, with its engineers and managers, plans the improvements; and when the proposed works are approved by the Ministry of Public Works, the French government provides funds for a large share of the cost. M. Despujols is director of the port, M. Beau engineer of new works, M. Baudelaire engineer of maintenance and repairs, M. Dherse engineer of dredging and approaches, M. Dutilleul engineer in charge of technical operations, and M. Dionis du Sejour chief of commercial service.

Inclosure of the great tidal basin was completed before the World War, but financial conditions after the war prevented the carrying out of the necessary works for the accommodation of steamers and the handling of freight. This situation was relieved, however, in 1922, by granting to the Compagnie Industrielle Maritime a 90-year concession for two important developments in the basin: (1) the construction and operation of two quays, with sheds and other facilities, on the north side of the basin, for both passenger and cargo service; (2) the establishment and operation of extensive facilities on the south side of the basin for the importation, storage and distribution of oil, this industry having grown considerably during and after the war.

These harbor-improvement works, completed in 1932 and 1933, were designed and constructed under the direction of P. Vimont and his successor Raoul Marry, chief engineer of the company.

Swamp Converted to Lakefront Park by CWA Workers in Ithaca

By Harry W. Eustance
City Engineer, Ithaca, N. Y.

LARGELY because preliminary planning was complete, Ithaca, N. Y., has been able to utilize Civil Works Administration forces to transform a large area of mosquito-breeding swampland into an attractive park. The 300 acres of land, on the shores of Lake Cayuga, have been held in city ownership for 25 years, awaiting a favorable opportunity for development. Originally the entire area was marshland, inundated at high stages of the lake or by floods from the streams. The hydraulic dredging of Cayuga Inlet, a part of the New York State barge canal system, made possible the partial reclamation of this area in 1910 by utilizing the dredged material as fill. The area partly reclaimed at that time included what is now the airport and the area east of Fall Creek known as Stewart Park. The grade resulting from the 1910 filling, however, was still subject to flooding at high stages of the lake. A permanent usable grade was established in 1928 when the channel was deepened.

The area on which the golf course is now being constructed has been utilized as a garbage and ash dump for about twenty years. The area that has been reclaimed by this means totals about 80 acres.

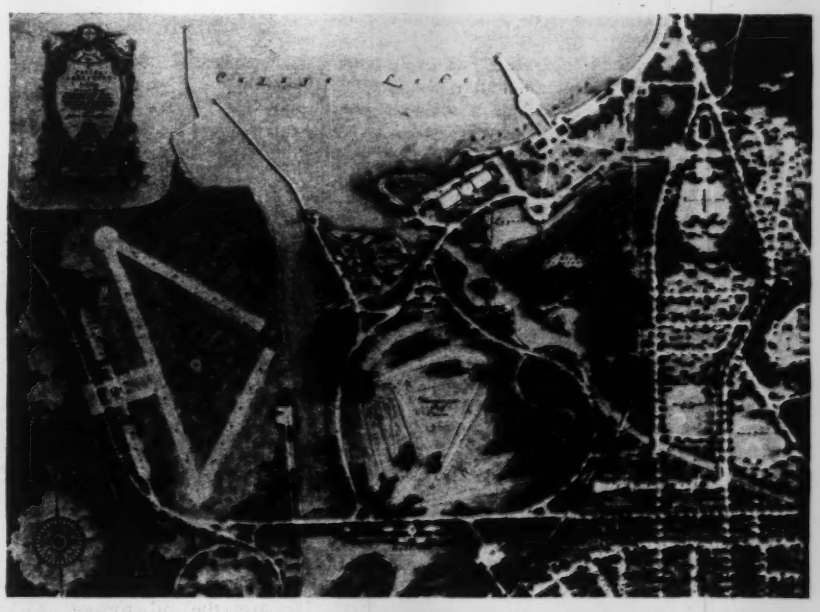


FIG. 1—MODEL of Ithaca's projected lakefront park, illustrating the plan for transforming an area of marshland and city dumps into an attractive recreation center. The model was made as a CWA project.

FIG. 2—SUSPENSION BRIDGE 112 ft. long over Fall Creek.

When the CWA program was inaugurated last fall, Ithaca had already developed in this area a usable airport and two athletic fields. A plan had been made for the development of the entire area, but because of the expense involved its accomplishment awaited some hoped-for benevolence. This seemed to arrive with the CWA. The park scheme was advanced by the city as its major project. Construction under CWA auspices continued throughout the winter and is now being carried to completion by the FERA.

About 300 men found employment on the job. At the airport, 40 acres of woodland were cleared, stumps were grubbed and burned, and the area was graded and seeded. A hangar 80x100 ft. is now under construction, and a surfaced runway 1,500 ft. long is being built.

East of the inlet a nine-hole golf course is now ready for seeding. On this area the ground was drained, water lines were installed, and a small clubhouse was built. In cooperation with Cornell University and the State Conservation Department, channels were dredged north of the golf course for fish ponds, fish and duck food and for mosquito-control study.

A channel navigable for pleasure craft was dredged along the southern boundary of the golf course, connecting the inlet and Fall Creek. Soil from this excavation was used to cover the ashes of the dump.

Fall Creek was also straightened and deepened to improve it, and incidentally produced gravel for the road fill and top soil for the golf-course fairways. An interesting roadway encircles the course, and the wood and stream banks are traversed by foot and bridle paths. A number of foot bridges, some rustic log structures, and two cable suspension bridges cross the stream. The logs and railings for the bridges were cut from the adjoining woods. Suspension-bridge cables were salvaged guy cables.

Drainage ditches were dug to eliminate standing water within the area, and much filling was done in existing low portions.

A feature of the job was the scheduling of work according to the expected conditions of weather and water levels. During the winter the stage of the lake is some 3 ft. lower than it is in the spring. Accordingly, the early winter season was utilized in grading creek banks, draining low areas and in creek dredging. These jobs could be worked to advantage while the water level was low. During mild weather, attention was concentrated on surface grading. Such jobs as clearing were saved for cold or stormy weather. The prolonged winter season, with its deeply frozen ground, was utilized to advantage for hauling fill from the ditch excavations to low-lying swamp areas, over which hauling would have been impossible after the spring thaw.

Another feature was the fact that machinery was used extensively on the job; hand labor supplemented rather than supplanted mechanical equipment. The presence of three shovels dredging the creek and channels, a bulldozer grading off the edge of the dump, a tractor pulling stumps and a tractor-grader shaping airport runways made the work proceed with reasonable unit costs. The city supplied the funds for material and equipment.

The total cost of the job, which is scheduled to be completed during the current month, will be about $135,000. Of this amount the material and equipment will have cost $35,000, and labor $100,000.

In connection with the development, a relief model having a scale of 160 ft. to 1 in. was constructed as a CWA project by Hewitt & Metzger, architects of Ithaca, under the direction of the writer as city engineer. The purpose of the model was to engage the interest of city officials and townspeople by showing in relief what the completed park would look like. Since its completion the model has been a popular local exhibit and has served well its desired function of arousing local interest and approbation of the work under way, at the same time giving the workers a definite goal. It was a common sight while the model was being exhibited in store windows to see a CWA worker, surrounded by listeners, explaining what he was working on at the park.

Some of the features built into the model still remain to be completed, notably the zoo, the park pier inclosing a swimming pool and ornamental fountain, the traffic bridges over Fall Creek connecting Stewart Park and the golf course, and that over Cayuga Inlet connecting the airport and the golf course. The projects under way are completely transforming the appearance of the area, and the model keeps the goal of the finished park constantly before the eyes of the people.

The enthusiasm of the supervisory board was reflected in the workers, all of whom were citizens and were laboring to develop a park of their own. The efficiency of the labor was higher than had been expected.

There still remain some 30 acres of swampland in this area. Most of this is located east of Stewart Park and is destined to be an animal park. Arrangements have been completed for a dredge and fill operation during the coming summer, which will complete the reclamation of this attractive park site.

FIG. 3—RUSTIC TRAFFIC BRIDGE over the southern end of the lagoon.

Bridge-Building Practices in the U.S.S.R.

Russia, in spite of lack of machinery and finished materials as well as of experienced engineers and workmen, is carrying out a notable program of bridge building

By C. L. Christensen
New York, N. Y.

THE AUTHOR of this article has just returned from three years in Russia, where he acted as consulting engineer to the federal government on railroad bridges and yard structures. With headquarters in Moscow, he traveled extensively in the European part of the U.S.S.R., inspecting field- and shop-fabricating work. Mr. Christensen is an experienced bridge engineer, having spent many years on railroad work in this country. He was designing engineer on the steel-arch bridge over the Niagara River for the Michigan Central. —EDITOR.

THE INDUSTRIAL EXPANSION of Russia has been accompanied by a thorough overhauling and extension of the means of transport in the U.S.S.R. The railroad system, particularly, has benefited from new construction, an important part of which is the building of bridges. In many respects the work is reminiscent of pioneer railroading in the United States a half century or more ago, although Russian rivers are in general much wider and on the average probably deeper than those encountered by early American railroad builders. Bridge building in the U.S.S.R. is carried on in an energetic and well-planned manner in spite of lack of equipment and, in some cases, of materials. Standards have been worked out not only for short spans of steel, concrete, stone and timber but also for truss spans up to 550 ft. long. The new bridges in some cases replace ferries, and in others are in undeveloped country. Old bridges are also being replaced or strengthened, to carry heavier locomotives. Some of the work is spectacular and difficult, as indicated by the accompanying views.

Organization

Bridge engineering work in Russia is organized along lines similar to those fitting a large system of American railroads. The complete designs for the superstructure and substructure of the bridges are made by the engineering department of the railroads. This department also handles directly most of the construction work by force account, using its own men and equipment except for the fabrication and erection of steel spans. The latter are made by the steel trust "Stalmost," but are subject to inspection by the railroads.

The field force for a large bridge is under the general direction of a manager, a man with talent for organization and with a general knowledge of construction work. He provides the material and equipment, engages the workers and takes care of their housing and feeding. He also handles relations with the authorities in charge of railroads, rivers and towns.

The chief engineer is thus enabled to concentrate on the technical problems of construction. He has on each side of the river an assistant chief engineer with a staff of engineers, technicians and skilled and unskilled workers.

The managers and chief engineers for the several bridges under construction report to the director of the bridge department "Mostotrust," of the federal railroad system, with offices at Moscow. He, in turn, reports to the director for new railroad construction who acts under the general orders of the People's Commissar for Transportation.

When a bridge is finished, it is inspected and accepted by the bridge engineer for the maintenance department, who has charge of repairs and reconstruction of all bridges from the Polish border to the Pacific Ocean.

The railroad organization includes also a separate scientific engineering department with various functions, such as research work in all branches of engineering. In the field of bridges this includes the evolution of new methods of design and construction and the testing of new and old bridges for deflections and stresses. The discussions at the meetings between this research department and the other departments are animated, interesting and mutually beneficial.

Engineers

The Russian engineers who graduated in the pre-war period are experts on theory, but some of them do not take sufficiently into account the actual conditions, such as shortcomings in the capacities of the workers and lack of materials, shop facilities and erection equipment. Their detail design is sometimes bad. As a result, there is often a gap between the theoretical design and the practical construction—a gap which has not yet been fully closed.

The younger generation of engineers, men from 25 to 35 years of age, have received an excellent technical education, and many of them, as students, have already taken part in practical work. They are very progressive and purposeful and look forward to the time when they will not only be acknowledged as experts in theory but will also excel in practical work in shop and field. They are very much interested in all engineering progress all over the world. It is easy for an American engineer to cooperate with them, for they are thankful for constructive criticism and appreciate all practical advice.

There are many women working in engineering offices not only as draftsmen but as skilled computers and designers and in some cases as squad leaders. They take eager part, too, in the discussions at the technical meetings.

FIG. 1—CANTILEVER SPAN of 600 ft. in the new bridge over the Volga River at Kostroma being brought to closure.

The women also work in the field where they may be in charge of concrete testing or act in the capacity of assistant engineers in the mixing and pouring of concrete, or they may be inspectors. The mixing of concrete seems to be a field for which women are well suited. Women engineers climb fearlessly around on scaffolds and give directions to the workers. Women also operate light hoists and punches and drills in the shops.

Steel bridges

The methods of detail design of steel bridges for the railroads are now similar to modern American practice, with the limitation that the rolling mills do not as yet furnish 8x8-in. angles or the large sections of I-beams and H-columns used here. The general specifications for fabrication and erection are also similar.

But the shopwork is not yet of the same quality as the work of a first-class American bridge shop, as the engineers and workers have not yet acquired sufficient skill and care. Sometimes tools are used which are worn and should have been repaired. Antiquated methods are used in assembling. Shipping and unloading are careless. There is a lack of jacks and cranes for erection. All in

FIG. 2—MILE-LONG railroad bridge over Dnieper River 50 miles upstream from the Dnieprostroy power station. Some 5,300 ft. long, it contains two 360-ft. steel truss spans, fourteen 170-ft., fourteen 95-ft. and three 50-ft. concrete arches, as well as four 53-ft. continuous concrete girder spans.

all, the inspectors of the railroad company have a difficult task.

The deficiencies in the quality of work are, in part, an inheritance from the pre-war past when there was insufficient contact between the higher engineering authorities and those in charge of work in the shop and field.

The willingness of the workers to do their best cannot be doubted. On a cold winter day I have seen a gang of steel workers on the top of a truss span drag around and erect top lateral members weighing about three-quarters of a ton apiece, using only their arms and shoulders because the traveler was busy somewhere else and there was no light crane available.

The quality of the structural steel in U.S.S.R. is about the same as the structural steel in America. Silicon steel has been introduced and used in a number of truss bridges; it is used on all new vertical-lift spans.

The types of bridges most frequently used are simple truss spans, cantilevers, and steel arches. At Saratof on the Volga there is now being completed a cantilever bridge flanked by a series of simple truss spans. The total length of this steel bridge is more than a mile. At Kostroma on the Volga a cantilever bridge with clear spans of about 600 ft. was finished three years ago (Fig. 1).

In the future, continuous bridges will very likely be preferred to cantilever bridges, wherever foundation conditions will permit. A continuous bridge was built over the Dnieper at Kiev 40 years ago. At Nischni Novgorod over the Oka River a street bridge consisting of a series of 410-ft. steel arches was finished about a year ago.

Erection

The erection engineers in U.S.S.R. are keenly interested in all innovations in the United States. For instance, erection by moving guy derricks on rails has been introduced both for steel bridges and for three-hinged steel centers for a series of concrete arches. The method used in raising the suspended span at the Carquinez Straits Bridge in California has also been studied and adopted.

In many cases the choice of the method of erection is limited by scant erection equipment and by the opinion that it is safer to use an old, laborious erection method with which everybody is familiar and for which equipment is available than a newer and simpler method which is untried and which necessitates new equipment. The following case is an instance:

When the traffic on a river necessitates that truss spans be built on shore and floated into place on the piers, it is a standard method in U.S.S.R. to build the span on a scaffold at right angles to the shore instead of parallel with it. When the span is finished, it is rolled longitudinally out on scaffolds on barges, which are anchored in all directions and kept at the proper elevation by pumping. A great number of solid steel rollers are placed between upper rails fastened to wood blockings under the bottom chord and a number of lower rails that are fastened to the top of the scaffolds.

It is claimed that this method of rolling saves timber for the scaffolding compared with the method of erecting the truss span on a scaffold parallel to the shore and rolling it out on trucks moving on two transverse extensions. This can hardly be the case for long and heavy trusses, since each part of the longitudinal scaffold must be designed for the stresses during the rolling. Furthermore, the rolling takes nearly two days and nights for a truss span 550 ft. long and produces high bending and shearing stresses in the bottom chords. It takes many men to adjust the rollers during the movement. The operation, however, is carried out successfully with very simple and primitive equipment, as are so many other complicated feats in bridge building in U.S.S.R.

Welding

Welding has been made the object of much study and many tests, and several welded-girder bridges and truss bridges have been built. One 150-ft. span shop- and field-welded has been fabricated for use on a branch railroad line. Another span of the same length has been designed for main-line traffic, with careful consideration of all bending and torsional stresses due to the deformation of the floor system and also of impact and reversal of stress. It is generally agreed that welded bridges offer so large a saving in the amount of steel that they can be built with comparative economy, even if the welding is made much stronger than necessary.

Electric arc-welding is used. Plans have been prepared for a 150-ft. welded test bridge with the purpose of testing welded connections under the moving load of locomotives. The main features of this bridge are as follows: The main material is made of ample strength to resist the stresses from the test load. All splices and connections can be bolted with ample strength. One splice or connection is not bolted but welded, with a strength computed to be less than the stress from the test load. When the connection fails, the truss span settles down on a series of bents placed at the panel points, with a vertical clearance slightly more than the maximum deflection at failure.

When the welded connection has been tested to destruction, the truss span is jacked up to its former elevation, the connection is bolted up, and some other splice or connection is welded and tested.

Concrete structures

The demands for industrial buildings and railway rails absorb practically the full output of the rolling mills, and are considered so important as to take precedence over bridge requirements. It has therefore been imperative that the railroads build reinforced-concrete bridges instead of steel bridges wherever possible, so as to reduce the tonnage of structural steel imported from abroad. A few years ago there were very few practical concrete engineers in Russia, but after several years of hard labor on formwork, mixing, pouring and curing, there has been developed a well-trained staff that is capable of handling all classes of concrete construction. For example, the concrete part of one of the long bridges consists of 4,600 ft. of concrete arches (see Fig. 2 and *ENR*, Aug. 10, 1933, p. 160).

There are three grades of cement in U.S.S.R., the middle grade being similar to American portland. The difference between the grades is mainly a difference in fineness.

There is good gravel available, and in some places rocks furnish good material for crushed stone. The sand, how-

ever, is rather fine and is therefore usually mixed with screenings.

The principles of concrete making are the same as those in America—with proper regard for water-cement ratio, grading and workability. At first, there was a tendency to be too saving with the cement, the result being porous concrete. Now concrete is made of great strength and density, and is carefully tested in field laboratories.

Three-hinged steel arches are extensively used as centering for reinforced-concrete arches of standard span and rise. They can be shipped from one job to another, and a great amount of work and material for wooden centering is thereby saved.

Fixed concrete arches are preferred, but when a slight vertical settlement of the piers is anticipated, two-hinged arches are used; and where a slight horizontal movement may occur, the arches are made three-hinged.

The reinforcing bars are spliced by lap welding. The welding is carefully inspected, and a certain number of the splices are tested to failure, which now nearly always occurs in the body of the bar.

For spans over streets and railroads the standard types are continuous frame bridges designed with theoretical expertness, but as yet with too little attention to practical details.

Up to a few years ago the floor for highway bridges was either made with plank on wooden stringers or very heavy macadam on a waterproofed concrete slab with a sand cushion on top. Now, however, the American type of floor, a 6-in. concrete slab with a wearing surface, is usually adopted.

The concrete slab for railroad bridges with ballast floor, used in general only on concrete bridges, is waterproofed, but it is also understood that the best waterproofing is a quick runoff of the water from a dense concrete slab with a smooth surface and a 2 per cent grade.

Precast concrete construction is in favor. For a while there was a tendency to use it even where there was no advantage. Concrete is always machine-mixed. I did not see any hand mixing of concrete during three years in U.S.S.R.

Timber structures

The U.S.S.R. has enormous resources of timber, and the Russians have a long experience in wooden construction and know how to make complicated connections with simple tools. It was, therefore, natural to expect that long timber truss bridges for railroad service would be used extensively during the period of industrial expansion, also that long wooden piles would be used extensively, as in the United States.

However, the timber in U.S.S.R. is at the present time only available in lengths of 22 to 28 ft., so if the bottom chord of a Howe truss is 100 ft. long and consists of four parallel lines of timber, there will be fourteen tension splices, each splice a source of expense, weakness, looseness and decay.

Deep-pile foundations and piles for falsework bents in deep water must be made by constructing composite piles, each consisting of four units, bolted together transversely and spliced with offset splices longitudinally.

The reason for the short lengths of timber lies in the necessity for handling it by primitive devices, and transporting it on single railroad cars, which in U.S.S.R. are 30 ft. or less in length. Cutting of long timber into short lengths and then splicing it is a waste of material and labor and will undoubtedly be changed in the next few years.

One of the most important consequences of the lack of long piles is that expensive foundation methods, such as pneumatic caissons, are used too widely.

Piledriving in Russia was primitive up to some few years ago, and this is very likely one of the reasons why long piles are not used. Modern steam piledrivers are now found in most of the construction camps for large bridges. Here and there are also seen home-made steam piledrivers of a very primitive design. But there are no rig-ups for driving batter piles, necessitating complicated devices for the bracing of vertical piles under water. And outrigger piledrivers for building railroad trestles are not available.

There is a great need for woodworking machinery for sawing and planing. Much of the sawing of planks is done by hand saws, operated vertically by two men, one standing on the ground and the other on a raised platform. The sharp ax in the skilled hands of a Russian carpenter is an all-around tool which makes up for the lack of much machinery.

The members for Howe trusses are sawed on all four sides, but stringers and caps for railroad trestles and scaffolds are made of round timber sawed or "axed' on two sides only. Composite girders consisting of several layers of beams are used extensively. The shear connections are in many cases made with ring dowels, which, however, have the drawback that they cannot easily be inspected and adjusted in case the wood shrinks or decays. The ring dowels are also used for tension splices of light trusses, and for the connection of the laterals to the top and bottom of heavy Howe trusses. Very little treated timber is used in U.S.S.R.

It is easy to foresee that all types of wooden construction will flourish in U.S.S.R. when the handling, shipping, treating and working of timber have been reorganized and modernized.

Foundations

The bottoms of the rivers in U.S.S.R. consist of layers of sand, gravel and clay, the solid rock in most places being deep down. The clay is extremely tough and hard to work, but it is not reliable. Water depths are subject to great variations, between high water in March and April and low water during the summer. Careful consideration must be given to possible scouring.

Pneumatic-caisson work has been, up to the present time, the favorite foundation method for deep bridge piers, since long wooden piles are not available and long and heavy concrete piles are difficult to handle with the present equipment. Deep cofferdam work is also difficult, because there is no rolled steel sheetpiling, and when riveted steel sheetpiles are used they are found to be of insufficient strength and flexibility in the interlockings. Open-caisson work is looked on with favor; it has been used successfully several times and will be used more and more in the future.

At the present time an extensive study is being made of airlocks so as to modify the present type, which is heavy and expensive and necessitates the use of a strong crane when the air-shaft is extended. Furthermore, the new regulations for pneumatic-caisson work in U.S.S.R. discourage the use of the same shaft for men and material, which is the present practice.

The excavation work and the sinking of the piers progress as rapidly as in the United States. When the work is finished, the shaft is salvaged except the part embedded in the roof of the working chamber. The working chamber invariably is made of concrete. In shallow water the working chamber is built on an artificial island. In deeper water the working chamber with its cofferdam extension is floated into place.

Bridge building in Russia, in brief, is being carried on satisfactorily, if somewhat primitively. But engineers and workmen are rapidly improving their knowledge and technique, and as modern equipment becomes available the U.S.S.R. will make many important contributions to the art of bridge engineering.

New Zealand Railway Grade Reduced Leaving Wellington

Grade reduction from a maximum of 2.75 per cent to 1 per cent by the construction of a 24½-mile diversion line, which also reduces the distance by 2½ miles, has been effected on the New Zealand Government Railways (3½-ft. gage) for the main line, running north from Wellington. Within a mile from the city the old line begins its steep ascent to the Khandallah Pass, at El. 518, with grades of 2.5 to 2.8 per cent; it then descends on grades of 1.8 to 1.5 per cent. The new line, with two tunnels of ¾ and 2¾ miles, ascends at grades of 0.9 and 0.75 per cent to a summit at El. 195 and then descends at 1 per cent. Incidental to this improvement is the reconstruction of passenger and freight-terminal facilities at Wellington.

STABILIZED SOIL-BOUND ROAD SURFACES

I—Theory of Soil Stabilization

Basic soil properties chiefly influential in designing stable mixtures and their determination by laboratory methods, with a consideration of calcium chloride as a moisture-fixing element

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WITH the primary and trunk-line road systems of the country becoming somewhat established, interest in the highway field is shifting to the vast mileage of secondary roads. This class of highway is no longer a mere rural road—it is a modern artery of transportation carrying the same class of traffic as does the primary route, though in lesser volume. A smooth durable surface is required, maintenance must be easy and construction costs kept low. The application of soil-stabilization processes to road wearing courses is a recent development that undertakes to meet these requirements.

Soil stabilization as applied to road-building is the proper combination or adjustment of the various soil fines and coarse materials to produce a mixture stable in all kinds of weather and under all conditions of traffic, using local materials. The U. S. Bureau of Public Roads has done extensive work in stabilizing highway subgrades. The same basic principles are applied to stabilizing road surfaces, though different technique is used and the surface is treated with calcium chloride to supply the necessary moisture for cohesion of the various materials. Within the past two years many miles of road surfaces have been so stabilized, notably in the state of Michigan.

The reasons for the increasing interest in the use of adjusted road materials for earth-road surfaces are: (1) the initial cost is low, as the necessary soils are usually available locally; (2) maintenance costs are low, for stabilized wearing surfaces need less dragging, blading and reworking, and require far less replacement stone or gravel than do unstabilized surfaces; (3) riding safety and comfort are increased, as stabilized surfaces are free from loose pebbles and dust and remain smooth for long periods.

Much of the early surface-stabilization work has been experimental; various mixtures of materials were applied to the road by different methods, with varying degrees of success. In cooperating with the highway engineers in this work, especially in Michigan, The Dow Chemical Company concluded that to develop the full possibilities of surface stabilization the rule-of-thumb procedure of the past should be replaced by scientific methods. As a result, this company has made a thorough study of characteristics of soils, supplementing that made by the Bureau of Public Roads. Certain definite conclusions as to proper adjustment of road soils were reached.

To prove these conclusions and to obtain further practical information, the company built a test road inside a large warehouse, where actual road sections of various soil mixtures could be tested and observed under truck traffic. To simulate wet-weather conditions a sprinkler system was installed, flooding the track with a downpour of water for wet-road tests. These tests have given much interesting and valuable information, the most important probably being definite proof that the life and wearing value of a stabilized surface are dependent upon proper adjustment and combination of road soils.

This series of four articles summarizes the progress that has been made to date in surface stabilization. The articles present information to enable highway engineers to judge the desirability of undertaking stabilization work in their individual localities. This first article summarizes soil properties in relation to stabilization, and the functions of calcium chloride in stabilized wearing surfaces. With these soil characteristics in mind, the results of the indoor road tests, to be described in the second article, can be readily understood. The two succeeding articles will describe successful construction methods and will present some available figures on construction costs.

The terminology and soil classifications used by the division of tests of the U. S. Bureau of Public Roads (*Public Roads*, October, 1931, p. 197) will be followed in presenting the theory of soil stabilization. The roads under consideration are the traffic-bound type, including all wearing surfaces in which the aggregate consists of stone or slag

FIG. 1—STABILIZED soil road of a proportioned mixture of gravel, sand and cohesive fine material with calcium-chloride mixture-fixation.

screenings, gravel, silt, clay or any or all of these materials.

Two of the principal elements controlling the service properties of such roads are: (1) the nature of the fine constituents and (2) their proportion to the coarse aggregate. A stable wearing course consists of a mixture of coarse aggregate, fine aggregate and binder soils, such as clay. Together, the fine aggregate and clay form a soil mortar in which the particles of coarse aggregate are securely embedded.

The constituents ordinarily found in road surfaces are classified as coarse material or gravel, coarse sand, fine sand, silt and clay. Gravel and sand are classified by sieve sizes, and silt and clay by particle diameter; the screen limits and particle sizes for each class of material are listed in Table I. Each of these constituents plays a part in contributing to the service properties of roads.

TABLE I — PROPERTIES OF REPRESENTATIVE SOIL CONSTITUENTS

Name	Particle Size, Diam. in In.	Sieve Size Passing Retained	Basic Property Exhibited When Alone	Predominant Property in Stable Mixtures
Gravel or Coarse Material	over 0.08	No. 10		
Coarse Sand	0.08 to .016	No. 10 No. 40	Internal friction	Internal friction
Fine Sand	0.016 to 0.002	No. 40 No. 270		
Silt	0.002 to 0.0002		Internal friction, no cohesion, rapid capillarity, compressibility, elasticity, sometimes.	Internal friction
Clay	less than 0.0002		High cohesion, slow capillarity, compressibility	Cohesion

Note: In this table the No. 40 sieve has been designated for separating the coarse and fine sand fractions, instead of the No. 60 sieve, which is used by the U. S. Bureau of Public Roads. This change was made to simplify laboratory testing and field control work.

TABLE II — CONSTITUENTS OF STABILIZED WEARING COURSES AS COMMONLY SUBDIVIDED

Terms Used in Specifications 1	Usual Subdivisions 2	U. S. Standard Series, or Diam. in In. 3	Laboratory Designations 4	5
Coarse aggregate	Gravel or coarse material	On No. 10	Coarse material	
Fine aggregate. Includes coarse and fine sands	Coarse sand	Through No. 10 on No. 40	Coarse sand	Soil mortar. Includes coarse and fine sand, silt and clay. Used for mechanical analysis.
	Fine sand	Through No. 40 on No. 270		
Soil binder. Mainly clay and silt but may contain coarse and fine sand	Silt	Through No. 270 More than 0.0002	Soil fines. Includes fine sand, silt and clay. Used for physical tests.	
	Clay	Less than 0.0002		

Soil mixtures having the most desirable properties are said to be stable. Soil stability is defined as resistance to lateral flow under load; actually it is a relative term. Sand or sandy gravels are unstable when dry, but are relatively stable when damp; clay and silt soils are unstable when wet, but are relatively stable when dry. Moisture content, therefore, is an important factor in controlling the degree of stability of soils. Small amounts of water apparently serve as an effective binding agent for soil grains, while excess quantities act as a lubricant. As road surfaces are alternately subjected to rains and to the heat of the sun, the most stable soil mixtures must be resistant to change in moisture content under varying weather conditions. Specifically, they must retain some moisture in dry weather, and they must not absorb too much water during periods of rainfall. The problem is to find combinations of materials that will yield the best all-weather stability.

Basic soil properties

The behavior of soil constituents can best be understood by studying the individual properties. The elementary or basic soil properties are: internal friction, cohesion, capillarity, compressibility and elasticity.

Internal Friction — Internal friction is the resistance of soil grains to sliding over each other and is indispensable in stable mixtures. It is the only basic property possessed in common by coarse material or gravel, coarse sand and fine sand; silt has some internal friction. The magnitude of the frictional property in a soil mixture depends on a number of factors, some of which are: shape of particles, particle size and grading, consolidation and load. Angular particles and those with rough surfaces offer greater resistance to sliding than do round or smooth particles. Large particles improve the interlocking effect of the material, while grading of particle sizes results in better embedment. The degree of consolidation governs the amount of frictional surface areas in contact. The amount of load affects internal friction.

Cohesion—Cohesion is the resistance of soil grains to being separated or pulled apart, and is necessary for stability in soil mixtures. It is the outstanding property of clay. The degree of cohesion of a clay, or of a soil containing clay, depends on a number of factors, among which are included clay content, particle size and shape, grading of clay particles, degree of compaction and moisture content. Small quantities of water supply a thin film over the grains, which increases their resistance to being pulled apart. This is called moisture-film cohesion and contributes effectively to wearing-course stability. Calcium chloride aids in supplying and retaining this form of cohesion by introducing and holding moisture in soil-bound wearing surfaces.

Capillarity—Capillarity is the ability of a soil to transmit moisture in all directions regardless of gravity or other forces. Capillarity governs the rate at which a soil tends to absorb water, the quantity which it takes up and the amount it will retain. This capillary behavior is directly related to particle size and grading, as these factors control the size of the pore spaces.

Of the various soil constituents, gravel and coarse sand show practically no capillarity, and fine sand has slight capillarity. Silt particles are smaller than fine sand, hence they transmit water more rapidly. Clay consists of still smaller particles than silt and consequently there is an attendant decrease in pore cross-section area, resulting in a further and very decided reduction of the rate of flow of capillary water. The cohesion of these soil grains causes them to resist separation, and this also makes entrance of water between the particles difficult.

Compressibility — Compressibility is the ability of a soil to be compacted with loss of water or air from its pores. Shrinkage upon drying, and expansion when wetted, are characteristics of soils such as clays or silts, which tend to absorb large amounts of water by capillarity. Soils of this type are sometimes called expansive, as distinguished from non-expansive soils, or those in which sands predominate.

Elasticity—Elasticity is the ability of a soil to be compacted without loss of water or air from its pores, and to rebound after the removal of load. This is a characteristic property of peat and of some silts. Neither compressibility nor elasticity are desirable wearing-surface or subgrade properties, and are generally associated with unstable materials.

The properties of the more common gravel and soil constituents are summarized in Table I. Particular note should be taken of the fact that in stable mixtures the undesirable properties of the constituents have become minimized and that the desirable properties (internal friction and cohesion) predominate.

Various terms are used to designate the screen fractions that are separated for test purposes from the mixtures of aggregates and soil that comprise the wearing surfaces of traffic-bound roads. These terms have been summarized in Table II. Soil fines, as used in the laboratory designation, include all of the fine sand, silt and clay. This fine material is used in the determination of the soil properties, particularly cohesion, by means of physical tests. Soil mortar, including all of the materials passing a No. 10 sieve, is the fraction of the sample that is used in making the separation of the fine constituents which is known as mechanical analysis.

There are two characteristics of soil fines to be determined: mechanical analysis or gradation, and cohesive properties.

Mechanical Analysis — Frictional

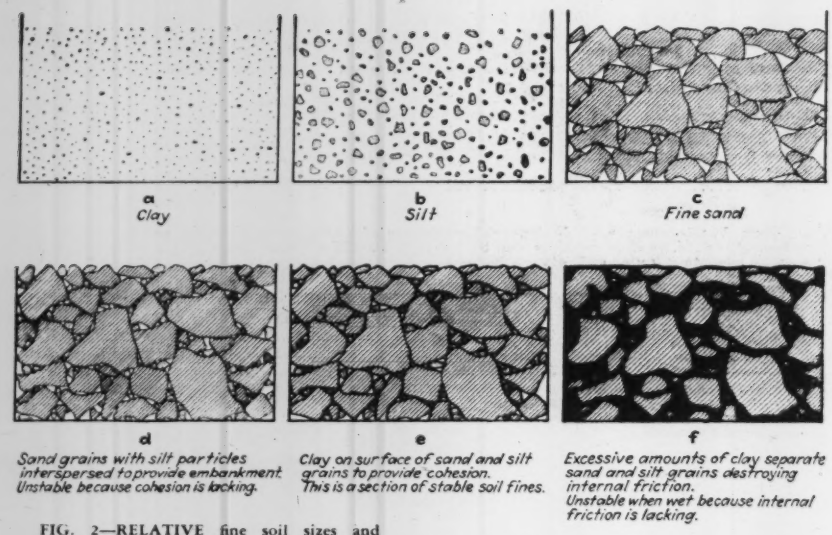

a
Clay
b
Silt
c
Fine sand
d
Sand grains with silt particles interspersed to provide embankment. Unstable because cohesion is lacking.
e
Clay on surface of sand and silt grains to provide cohesion. This is a section of stable soil fines.
f
Excessive amounts of clay separate sand and silt grains destroying internal friction. Unstable when wet because internal friction is lacking.

FIG. 2—RELATIVE fine soil sizes and their relation to stability of road-surfacing mixtures.

properties are revealed by the mechanical analysis. Fine material passing the No. 10 sieve is soaked in water, then placed in a stirring machine, treated with a small measured amount of sodium silicate, and agitated for several minutes. Following this treatment, the soil is suspended in a liter of water in a graduated cylinder, and the suspended solids are measured using a special hydrometer that reads directly in grams of solids in suspension per liter of water. After 35 to 40 sec. all of the sands settle out and only the silt and clay remain in suspension; a hydrometer reading gives the quantity of these present. At the end of one hour, only the clay remains in suspension. At the end of 25 hours the material remaining in suspension is the colloidal fraction. The fine and coarse sand content of the original material is determined by screening the residue from the cylinder.

This test gives the grading of the frictional materials, and also the clay content. However, as clays differ widely in their cohesion, a test that shows the combined cohesive value of all materials passing the No. 40 sieve is used as a measure of this property on all types of soils. The fraction of the sample that is used is sometimes called the soil fines, and includes all the fine sand, silt and clay in the material to be tested. The relative sizes of each of these particles and their relations to stability are illustrated in Fig. 2. The relative size of clay, silt and fine sand grains are shown in sketches *a*, *b* and *c*, respectively. Sketch *d*, also drawn to the same scale, shows how silt-size particles may be interspersed between the sand grains, providing embedment and additional frictional contact faces. Sketch *e* in the figure shows the sand and silt particles coated with a film of clay, representing a mixture having relatively high stability, as the quantity

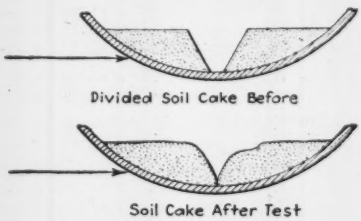


FIG. 3—LIQUID LIMIT of soil determined by hand-jarring soil paste in a shallow bowl.

of clay is not great enough to separate the frictional faces.

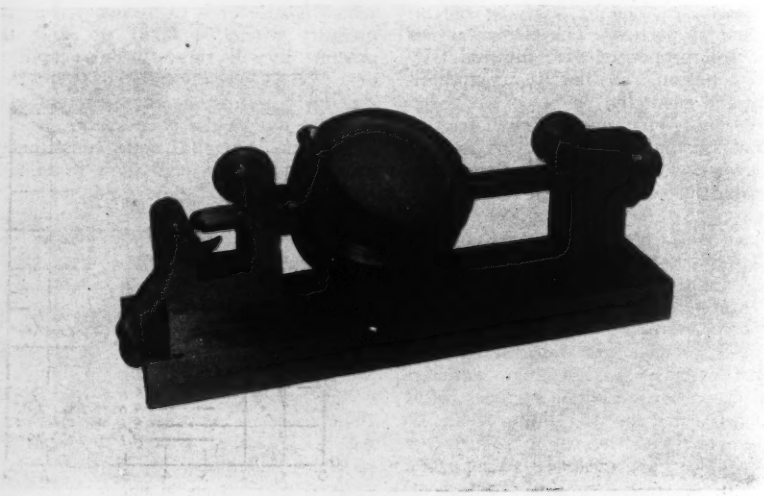
The effect of excessive quantities of clay in separating the sand and silt grains, thus destroying their frictional and embedment values, is shown in sketch *f*, Fig. 2. The effect of this type of sand clay in practice, if it is combined with an aggregate in a wearing-course mixture, is to provide a surface that is slippery when wet. The more stable proportions of soil fines, shown in sketch *e*, provides a surface that is not slippery during rainy weather. The No. 40 screenings from the wearing course must contain more than one-third sand-size particles, to insure sufficient frictional material to prevent slipperiness.

Cohesion Tests—Two tests are used to find a measure of the degree of cohesion possessed by soil binders, including clays and sand clays or the soil fines portion of wearing courses. They are the plastic-limit test and the liquid-limit test, and the results are used to compute a value known as the plasticity index. The plasticity index is the measure of cohesion. (See *Public Roads*, October, 1931, p. 202; "Road Stabilization Testing Procedure," Soil Stabilization Dept., The Dow Chemical Company.)

The plastic limit is the smallest water content at which a soil exhibits plastic properties as distinguished from those of a solid. Slight variations in moisture content at this point cause a sharply defined change in characteristics. The plastic limit of a soil is the lowest amount of water, measured in percentage of weight of dry soil, needed to moisten it to the point at which the soil can be rolled into a thread $\frac{1}{8}$ in. in diameter without breaking into pieces.

The liquid limit may be defined as the smallest water content at which a soil exhibits liquid properties as distinguished from those of a plastic material. Here also a slight variation in the moisture content of the soil causes a sharply defined change in properties. The critical amount of water required to bring about this change is determined by a flow test. The liquid limit of a soil is determined by mixing the soil with sufficient water to render it pasty. The paste is spread over the side of a small bowl (Fig. 3) in a layer about $\frac{1}{2}$ in. thick, and is then divided into two parts with a grooving tool. The dish is held

FIG. 4—TESTING MACHINE for determining liquid limit eliminates personal factor in jarring by hand.



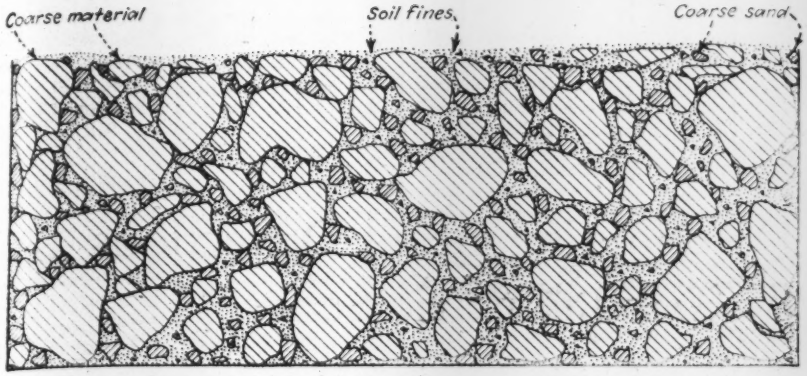


FIG. 5—STABILIZED GRAVEL, showing relation of gravel and sand aggregates to cementing soil-fines mixture.

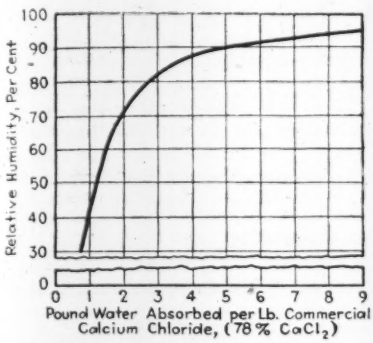


FIG. 6—WATER ABSORBED by calcium chloride at various relative humidities.

firmly in one hand, with the groove parallel with the line of sight, and ten blows are struck with a horizontal motion against the palm of the other hand. If the lower edges of the groove do not flow together, the moisture content is below the liquid limit; more water should be added, and the test should be repeated. If the lower edges meet before ten blows have been struck, the moisture content is above the liquid limit, and dry soil should be added and the procedure repeated. When the lower edges of the two portions of the soil cake just flow together after ten blows have been struck, the moisture content of the soil equals the liquid limit.

The sharpness of the blows required for the test can be determined best by testing samples having known liquid limits. These may be secured from established laboratories such as the Subgrade Soils Laboratory of the U. S. Bureau of Public Roads. The Dow Chemical Company has developed a testing machine (Fig. 4) that eliminates the personal factor from this test.

The plasticity index is the percentage of moisture content of a soil at the liquid limit less that at the plastic limit. The theoretical basis for consideration of this value as a measure of cohesion follows. At the plastic limit all of the soil grains are coated with very thin films of water, which act as a lubricant, permitting them to slide over each other under the pressure exerted by the hand, but without destroying the true cohesion. If the thickness of the films of water is increased slightly, the grains are lubricated to a greater extent, or some of the cohesion of the grains is overcome, and the soil mass becomes softer. When the thickness of the lubricating water films is increased to the point at which flow takes place as determined by the liquid-limit test, the cohesion of the soil grains is considered as having been reduced to zero. The change in thickness of films that results is about proportional to the difference in water content between the plastic and liquid limits. Hence, this difference, the plasticity index, serves as a measure of soil cohesion.

Stable soil fines

A cross-section of stable surfacing gravel (maximum size about $\frac{3}{4}$ in.), in which the coarse material and coarse sand are represented as two sizes of aggregate, cemented together with a soil fines mixture, is shown in Fig. 5. For maximum stability, it is evident that the composition of the wearing course must fulfill the following requirements:

1. True cohesion of soil fines. Cohesion must be sufficient to hold the stones securely in place against the abrasive action of traffic; this degree of cohesion is obtained when the plasticity index ranges between 6 and 14.

2. Resistance of soil fines to water absorption. This is necessary to limit the formation of mud during wet weather. High cohesion aids in supplying resistance to water entrance, hence the plasticity index test is also a test for resistance to water entrance.

3. Moisture film cohesion in soil fines. Full stability in dry weather requires the retention of moisture in the wearing course to prevent the loss of some of the clay and consequent cohesive properties. Calcium chloride serves this purpose by absorbing moisture from the air and holding it in the surface.

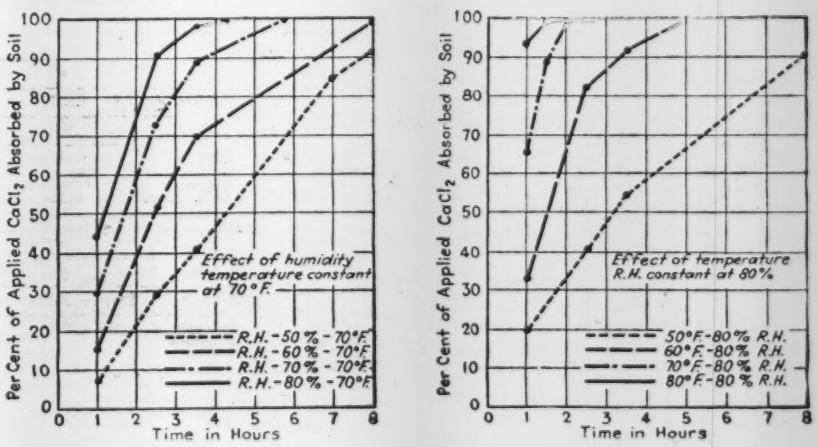
4. Internal friction of soil fines. Enough gritty material must be present to prevent the mixture becoming slippery when wet. This requires that at least one-third of the soil fines fraction be fine sand.

5. Quantity of soil fines. Ample soil fines must be present to fill the voids between the particles of coarse material and coarse sand. This improves embedment of the coarse materials and helps to prevent water entrance. From 30 to 50 per cent of soil fines by weight are required to accomplish these purposes.

Function of calcium chloride

The function of calcium chloride in wearing-surface stabilization is to provide the necessary moisture for proper cohesion in dry weather. The action of calcium chloride in the usual commercial flake form, when applied to a road under proper conditions, takes place in two steps: first, the absorption of water occurs to form a solution; and second, the resulting liquid adjusts itself to a concentration that is dependent on atmospheric temperature and humidity. Only a small amount of water is required to complete the solution of the calcium chloride. Generally, 1 lb. of

FIG. 7—RATE OF SOLUTION of calcium chloride as affected by temperature and humidity.


Per Cent of Applied $CaCl_2$ Absorbed by Soil
Time in Hours
Effect of humidity temperature constant at 70° F.
R.H. - 50% - 70° F.
R.H. - 60% - 70° F.
R.H. - 70% - 70° F.
R.H. - 80% - 70° F.
Per Cent of Applied $CaCl_2$ Absorbed by Soil
Time in Hours
Effect of temperature R.H. constant at 80%
50° F. - 80% R.H.
60° F. - 80% R.H.
70° F. - 80% R.H.
80° F. - 80% R.H.

calcium chloride will dissolve in less than 1 lb. of water.

For a given relative humidity the rapidity of solution of the calcium chloride increases with higher temperatures, although the total amount of water absorbed is not appreciably affected. If the relative humidity is increased, however, both the rate of absorption and the total amount of water absorbed are increased. Fig. 6 shows the total quantities of water which 1 lb. of commercial calcium chloride will absorb at various relative humidities.

After calcium chloride has been applied to a road and has absorbed sufficient moisture to form a solution, the solution has a tendency to take on or to give up water, depending on subsequent temperature and relative humidity conditions of the atmosphere. When water evaporates from these solutions, the rate at which this takes place decreases as the content of calcium chloride increases, until a strength of solution is reached at which evaporation stops. This solution strength is dependent on the moisture content of the air to which the solution is exposed, as well as on the temperature.

Under conditions of high humidity no evaporation will take place, but the solution will absorb water from the air, thus becoming diluted to a lower concentration. This action usually takes place at night on road surfaces that have been treated with calcium chloride. Rising temperatures during the day cause the evaporation of some of this moisture, but this action is retarded if the wearing course of the road is stabilized. Moisture that is lost during the day is always regained when higher humidities return as is usually the case at night.

Calcium chloride does not decompose or lose any of its properties upon long exposure to the atmosphere. Whatever loss there may be from the roads usually takes place in the solution form by being thrown from the road by traffic or washed out of loose sandy gravels by rainwater. These types of loss are reduced to a minimum in stabilized wearing courses, as the soil properties are balanced to reduce pitting and retain the calcium chloride.

In dry weather most of the moisture-holding solution will be found at or close to the surface of stabilized roads. Rainfall dilutes the solution somewhat, resulting in penetration of the road surface by means of gravity and capillarity. As the clay absorbs water, it expands and seals off the road surface, causing most of the subsequent rainfall to be delivered to the side ditches.

When the rainfall stops and the road surface starts to dry, the water containing calcium chloride is returned to the surface by capillarity. Evaporation of moisture continues until the concentration of the solution has again become adjusted to atmospheric humidity.

The chief property of calcium chloride in the treatment of all gravel road surfaces is its ability to furnish and to retain moisture-film cohesion. In addition to providing the cohesion moisture necessary to the stability of the road, calcium chloride also has the qualification of providing a dustless surface.

The next article in this series will describe the results of tests made on various sections of stabilized road at the indoor laboratory of The Dow Chemical Company at Midland, Mich.

Determining Beam Deflections by Trigonometric Series

By A. A. Jakkula
Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich.

ALTHOUGH there are many methods for finding the deflection of a beam at a given point, there are only two methods for finding equations to represent the deflection of a beam at any point. In the accompanying diagram is shown a beam with a triangular load. To find the equation of the elastic line, the method employed in most texts is to set up and solve the differential equation

$$EI\frac{d^2y}{dx^2} = -M \qquad (1)$$

For the loading shown on p. 665 the value of M would have three distinct algebraic forms so that the equation for y would be found in three

TABLE 1—VALUES OF THE COEFFICIENT A_n

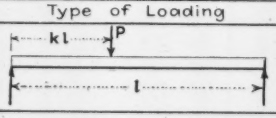
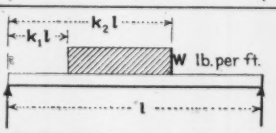
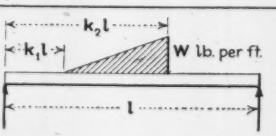
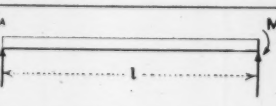
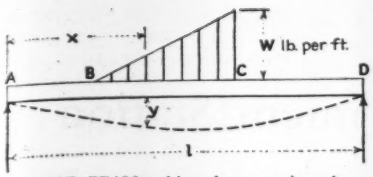
No	Type of Loading	An
I		$\frac{2Pl^3}{EI\pi^4n^4}\ \sin n\pi k$
II		$\frac{2wl^4}{EI\pi^5n^5}\left[\cos n\pi k_1 - \cos n\pi k_2\right]$
III		$\frac{2wl^4}{EI\pi^5n^5(k_2-k_1)}\left[\frac{1}{n\pi}(\sin n\pi k_2 - \sin n\pi k_1) - (k_2-k_1)\cos n\pi k_2\right]$
IV		$\frac{2(M_A \pm M_B)l^2}{EI\pi^3n^3}$ + if n is even − if n is odd

TABLE 2—VALUES OF Sin $\frac{n\pi x}{l}$

	Values of n				
×	1	2	3	4	5
.1l	.30902	.58779	.80902	.95106	1.00000
.2l	.58779	.95106	.95106	.58779	0
.25l	.70711	1.00000	.70711	0	—.70711
.3l	.80902	.95106	.30902	—.58779	—1.00000
.33l	.86603	.86603	0	—.86603	—.86603
.4l	.95106	.58779	—.58779	—.95106	0
.5l	1.00000	0	—1.00000	0	1.00000
.6l	.95106	—.58779	—.58779	.95106	0
.67l	.86603	—.86603	0	.86603	—.86603
.7l	.80902	—.95106	.30902	.58779	—1.00000
.75l	.70711	—1.00000	.70711	0	—.70711
.8l	.58779	—.95106	.95106	—.58779	0
.9l	.30902	—.58779	.80902	—.95106	1.00000



SIMPLE BEAM subjected to a triangular load and the resulting deflection curve.

sections, one applying for values of x between A and B, another for values of x between B and C, and the third for values of x between C and D. In the solution of Eq. (1) two constants of integration would appear for each of the three sections, giving six in all. These constants must be evaluated from the end conditions and the conditions of continuity, sometimes a laborious task.

If, however, the value of y is represented by a trigonometric series, as is done by S. Timoshenko[1] and writers[2] on the exact theory of suspension bridges, the disadvantages and the difficulties of the usual method disappear. The series employed has the form

$$y = a_1 \sin\frac{\pi x}{l} + a_2 \sin\frac{2\pi x}{l} + \\ -a_3 \sin\frac{3\pi x}{l} + \ldots\ldots \quad (2)$$

This series is applicable for all values of x, and the coefficients can be easily evaluated. Its disadvantage lies in the necessity of considering several terms before sufficient accuracy is obtained. This paper will show how many terms are needed to get accuracies within 1 per cent, an accuracy sufficient for all practical purposes.

In Table 1 is shown the general form of the coefficient a_n for several types of loading. These coefficients are perfectly general in their applications. In case III, k_1 can be larger than k_2 with no error. In case IV, if M_A and M_B are assumed positive as shown, the values of y will be negative. Practically any other case of loading can be obtained from these four merely by adding together the proper coefficients. Case IV in combination with the other cases furnishes a solution for the deflection of continuous beams.

These coefficients have been worked out by the method given in references 1, *2a* and *2b*. They can also be worked out by the general method given in mathematical treatises on Fourier's series. The method used, however, is much simpler than that given in the general treatment.

Table 2 gives values of $\sin\frac{\pi x}{l}$, $\sin\frac{2\pi x}{l}$, etc., for various values of x. Its use will be found valuable in the solution of numerical problems.

In Table 3 is shown a study of the convergence of the series for different loading conditions and for several points along the beam. Under each value of the deflection by the series is shown the percentage error in the value. In all cases except two, an accuracy within 1 per cent is obtained in three terms.

This method, it is felt, is an easy way to obtain deflections at any point in a simply supported beam. It is particularly convenient for those cases of loading for which the handbooks give no solution. Unfortunately the series method does not work out well for cantilever beams, because too many terms are needed to get an accuracy within 1 per cent.

REFERENCES

1. S. Timoshenko, "Strength of Materials," p. 417.
2. *(a)* S. Timoshenko, *Transactions*, Am. Soc. C. E., Vol. 94, p. 377.
   (b) G. C. Preister, *Engineering Research Bulletin*, No. 12, University of Michigan.
   (c) E. Steuerman, *Transactions*, Am. Soc. C. E., Vol. 94, p. 394.
   (d) *Engineering*, April 29, 1927, p. 506; Jan. 6, 1928, p. 1.
   (e) A. A. Jakkula, *Civil Engineering*, Vol. 3, p. 491.

The author wishes to acknowledge the assistance of Victor A. Roudoy, graduate student in civil engineering, University of Michigan, in the calculations of the numerical problems shown.

TABLE 3—CONVERGENCE OF THE TRIGONOMETRIC SERIES

Type of Loading	Position of Load	Value of x	Exact Deflection	Coefficient of $\frac{Pl^3}{EI}$, $\frac{Wl^4}{EI}$ etc. by Series				
				1 Term	2 Terms	3 Terms	4 Terms	5 Terms
I	$K = .5$	.51	.02083 $\frac{Pl^3}{EI}$	.02053	.02053	.02079	.02079	.02082
				1.44	1.44	0.19	0.19	.04
	$K = .5$	.251	.01432 $\frac{Pl^3}{EI}$	.01452	.01452	.01434	.01434	.01432
				1.39	1.39	0.14	0.14	0
	$K = .25$	.51	.01432 $\frac{Pl^3}{EI}$	.01452	.01452	.01434	.01434	.01432
				1.39	1.39	0.14	0.14	0
	$K = .25$	.251	.01172 $\frac{Pl^3}{EI}$	.01027	.01455	.01168	.01168	.01169
				12.4	1.45	0.34	0.34	.26
II	$K_2 = 1$	.51	.01302 $\frac{Wl^4}{EI}$	.01367	.01307	.01302	.01302	.01302
	$K_1 = 0$			0.38	0.38	0	0	0
	$K_2 = 1$	.251	.00928 $\frac{Wl^4}{EI}$	.00924	.00924	.00928	.00928	.00928
	$K_1 = 0$			0.43	0.43	0	0	0
	$K_2 = .67$	.51	.00659 $\frac{Wl^4}{EI}$	.00654	.00654	.00656	.00656	.00656
	$K_1 = .33$			0.76	0.76	.45	0.45	0.45
	$K_2 = .67$	.251	.00458 $\frac{Wl^4}{EI}$	.00462	.00462	.00460	.00460	.00460
	$K_1 = .33$			0.87	0.87	0.44	0.44	0.44
	$K_2 = .5$	.51	.00651 $\frac{Wl^4}{EI}$	.00654	.00654	.00651	.00651	.00651
	$K_1 = 0$			0.46	0.46	0	0	0
	$K_2 = .5$	.251	.00505 $\frac{Wl^4}{EI}$	.00462	.00503	.00505	.00505	.00505
	$K_1 = 0$			8.52	0.40	0	0	0
	$K_2 = .5$	.751	.00423 $\frac{Wl^4}{EI}$	.00462	.00421	.00423	.00423	.00423
	$K_1 = 0$			8.44	0.43	0	0	0
III	$K_2 = 1$	.331	.00549 $\frac{Wl^4}{EI}$	.00566	.00548	.00548	.00549	.00549
	$K_1 = 0$			3.10	0.18	0.18	0	0
	$K_2 = 1$	.51	.00651 $\frac{Wl^4}{EI}$	.00654	.00654	.00651	.00651	.00651
	$K_1 = 0$			0.46	0.46	0	0	0
	$K_2 = 1$	.671	.00583 $\frac{Wl^4}{EI}$	.00566	.00584	.00584	.00583	.00583
	$K_1 = 0$			2.91	0.17	0.17	0	0
	$K_2 = 1$	.51	.00234 $\frac{Wl^4}{EI}$	.00237	.00237	.00234	.00234	.00234
	$K_1 = .5$			1.28	1.28	0	0	0
	$K_2 = 1$	.251	.00150 $\frac{Wl^4}{EI}$	.00168	.00188	.00150	.00150	.00150
	$K_1 = .5$			12.00	1.33	0	0	0
	$K_2 = 1$	.751	.00190 $\frac{Wl^4}{EI}$	.00168	.00168	.00191	.00191	.00191
	$K_1 = .5$			11.58	1.05	0.53	0.53	0.53
IV	M_A and M_B as shown in Table I	.51	$-.06250 \frac{(M_A + M_B)l^2}{EI}$	−.06450	−.06450	−.06211	−.06211	−.06263
				3.20	3.20	0.62	0.62	0.21
	M_A as shown	.251	$-.05469 \frac{M_A l^2}{EI}$	−.04561	−.05367	−.05536	−.05536	−.05590
	$M_B = 0$			16.66	1.87	1.23	1.23	0.57
	$M_A = 0$	.251	$-.03906 \frac{M_B l^2}{EI}$	−.04561	−.03755	−.03924	.03924	.03887
	M_B as shown			16.76	3.87	0.46	0.46	.049
	$M_A = 0$	.331	$-.04938 \frac{M_B l^2}{EI}$	−.05586	−.04888	−.04888	−.04975	−.04930
	M_B as shown			13.15	1.02	1.02	0.75	0.16

Research Notes

—Ohio State's Engineering Experiment Station

THIS IS THE SECOND of a series of articles briefly recording current research and important recent results at the college laboratories. The first article, on the Fritz Engineering Laboratory at Lehigh University, appeared in the Feb. 15, 1934, issue, p. 225. —EDITOR.

THE Engineering Experiment Station of Ohio State University was established in 1913 by a law providing that "The purpose of the station shall be to make technical investigations and to supply engineering data which will tend to increase the economy, efficiency and safety of the manufacturing, mineral, transportation and other engineering and industrial enterprises of the state, and to promote the conservation and utilization of its resources." This mandate is broad enough to take in the whole field of enginering. Naturally enough, many of the projects belong in the civil branch.

A compilation of the existing streamflow records was the first project established in the station, with Prof. C. E. Sherman as investigator. Ohio climate was included as having a special bearing on the project as a whole. Publications that have been issued are:

Bulletin 26, Climatological History of Ohio, by W. H. Alexander, 1924.
Bulletin 49, Run-off Formulas and Methods Applied to Selected Ohio Streams, by John C. Prior, 1929.
Bulletin 73, Ohio Streamflow, Part I; Areas of Lakes and Drainage Basins; Run-off Records Prior to 1921, by C. E. Sherman, 1932.

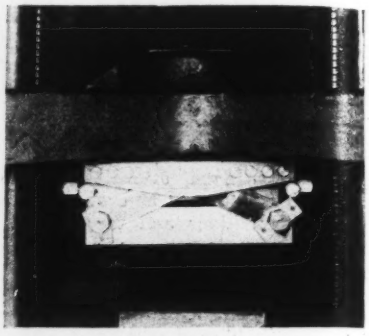
Rainfall and streamflow information is published periodically in the *Station News* from records collected by the U. S. Weather Bureau and the Water Resources Branch of the U.S.G.S. The plan is to put out a bulletin every ten years, with the streamflow and weather records of the previous decade.

Subsoils

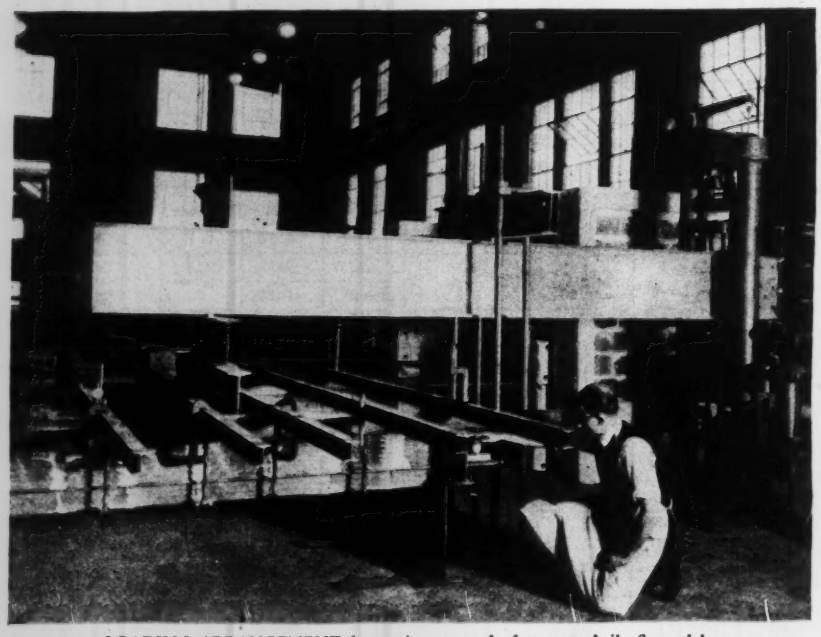
Highway subsoils have been the subject of an inquiry that started in 1924 with the cooperation of the Experiment Station, the U. S. Bureau of Public Roads and the Ohio department of highways under the direction of Prof. F. H. Eno. Since 1931 the project has been a joint study of the station and the highway department. The work has included tests of soil properties, measurement of heave from expansion and freezing, all kinds of drainage, and use of different substances to treat the natural soil. The investigator has been called in for consultation on problems of slides, slips and bog-holes. Publications are:

Bulletin 39, Preliminary Report of Highway Subsoil Investigation in Ohio, 1928.
Circular 20, A Decade of Progress in Highway Research, 1930.
In press: The Effect of Soil, Water and Climate on the Construction, Life, and Maintenance of Highways.

Professor Eno has concluded that the Atterberg lower liquid and lower plastic limits, clay content (as shown by hydrometer tests) and volumetric change are sufficient information about soils to classify them for construction purposes. Colloidal content is the effective factor. Subdrainage diminishes frost upheaval and softening, reduces maintenance costs, increases the life of the pavement and in general increases the economy and safety of the road. Relocation around bogs is recommended where practicable; otherwise, excavation and, where the material is very liquid, use of explosives. On the subject of admixtures or treatments, the results are variable, but comfort may be drawn from the fact that out of 51 treated sections beneath concrete pavement only 9 have shown worse cracking than the untreated sections with which they were compared. The distance between transverse joints has an important bearing on cracking, and should not be more than 30 or 35 ft.



LOAD-TILTING DEVICE used in masonry pilaster tests to simulate the effect of load application through a beam whose deflection has caused its end to rotate.



LOADING ARRANGEMENT for testing a panel of structural-tile floor slab.

Concrete research

Investigations centering on concrete research are active, and some of the more important may be briefly reviewed as follows:

Gunite encasement of corroded steel members, with replacement of the corroded metal by reinforcing rods, was found to be feasible. The results were published in Bulletin 37, by Professors Clyde T. Morris and J. R. Shank.

Plastic-flow investigations were begun in a small way in 1918 by Prof. J. R. Shank. The results coincided well with those at the University of California and brought out some additional features. This work, particularly as regards bond flow, is being continued in an attempt to bring all the known data to a point where designers may take into

account the predicted changes of stress and deformations.

A workability meter is being developed by Professor Shank on the principle of measurement of the amount of work necessary to form a mass of green concrete rather than to deform it. A tentative observation is that, for a given water-cement ratio and given workability, optimum yield occurs at a sand-coarse aggregate ratio of about 1:1.

Bond of concrete to reinforcing steel is the object of inquiry by Professor Shank in small-beam tests, with attention to the effects of admixtures and of surface conditions and coatings such as mud, paraffin oil, paint, sandblasting and polishing. The work so far has been done on cold-rolled steel, polished bars of which gave u (ultimate) as low as $0.02f'_c$. The tests will be repeated with plain hot-rolled bars.

Arch Study. During 1931-1932 Prof. Clyde T. Morris supervised a study of the stresses in a continuous-arch system by the celluloid-model deformeter method. The arches were prototypes of the concrete arches tested at the University of Illinois under the auspices of the U. S. Bureau of Public Roads and the committee on arches of the Am. Soc. C. E.

An admixture study in cooperation with the Calcium Chloride Publicity Committee was under the direction of Prof. R. C. Sloane, department of civil engineering, and Dr. W. J. McCaughey, professor of mineralogy. Bulletin 61, published in 1931, reports that calcium chloride accelerates the hydration of portland cement up to about three days and after thirty days, retarding it in the intervening period, that calcium-chloride-treated concrete has a higher early expansion than plain concrete and shrinks more than plain concrete during times of medium or high humidity and less during a period of low humidity; and that calcium-chloride-treated mortar retains more water than plain mortar. The work is being continued at the Bureau of Standards in Washington.

Heating aggregates, so that the concrete is placed at a temperature above 70 deg. F., reduces strength and speeds up setting. This is the conclusion of Professor Shank after an investigation of the subject. Variations in the results make a quantitative statement questionable, but he suggests as an average the formula

Strength at $T + 70$ deg. $= \left(1 - \frac{T}{200}\right)$ strength at 70 deg., the T being the increase in temperature over 70. A 20-deg. increase in temperature cuts down the setting time about 30 per cent.

Early-strength experiments by Prof. G. E. Large show clearly that today's improved cements have pushed Abrams' famous curve for the w/c-strength relationship to a much higher level, though the general shape is the same.

He recommends for 28-day strength laboratory concrete $\frac{14{,}000}{3.1^x}$ instead of Abrams' $\frac{14{,}000}{7^x}$ where x is the w/c ratio.

The tests show, moreover, that modern cements attain at 7 days a larger proportion of the 28-day strength than when Slater's formula, $S_{28} = S_7 + 30\sqrt{S_7}$ was devised, so that present-day use of that formula overpredicts 28-day strengths. Accordingly, Professor Large proposes for standard portlands the formula

$$S_n = \frac{14{,}000}{3.1^x}\left(1.2 - \frac{1.2}{1 + 0.2\,(n - 0.5)}\right)$$

n being any age in days up to 28. The bracketed term closely approaches unity at 28 days.

High-early-strength portland cements appeared unlikely to have a different 28-day strength from the standard, their advantage lying mainly in the first five days after placing.

TIRE FRICTION on pavement surfaces is studied by the use of this dynamometer trailer. Recording instruments are mounted in back seat of the car.

Masonry studies

Masonry construction has been the subject of a number of experiments. Pilasters were investigated by means of a load-tilting device that simulated the effect of application through a beam, with the maximum deflection encountered in practice. Professor Shank and H. D. Foster, the investigators, published their findings with design data in two bulletins, No. 57 for brick and tile pilasters, and No. 60 for concrete block.

Reinforced brickwork slabs and beams were tested by Professor Shank who concluded that

1. A theoretical basis for design similar to that for reinforced concrete can be worked out.
2. Large variations must be expected in the E of brickwork.
3. There is little or no plastic flow.
4. Water-absorbent characteristics of the brick must receive careful attention.
5. The question of bond is important.

Flat-arch floor tests by Professors G. E. Large and C. T. Morris are reported in Station Bulletin No. 78. Ninety tests were made on 12-in. tile slabs, spans varying from 6 to 12 ft., tierods from $\frac{3}{8}$ in. to 1 in. in diameter, with 10-in. floor beams. For the common case of 6-ft. span with $\frac{3}{4}$-in. tierods spaced 5 ft., ultimate strength was 700 lb. per sq.ft. with failure due to yielding of the tierods. Upward revision of the standard safe-load tables is recommended.

Concentrated loads on slabs is the subject of Bulletin 80 covering the work of Prof. C. T. Morris for the committee on masonry of the structural division of the A.S.C.E., showing close agreement between analytical and experimental recults, and giving design rules with simplified approximate equations.

Tall building frames

Studies of tall-building frames with particular reference to design for wind or earthquake shock have been under way at Ohio State University for about 30 years. "Stresses in Tall Buildings," by C. A. Melick was published in 1912 as Bulletin 8 (out of print) of the college of engineering. The following bulletins on this project have been issued:

No. 40, Dead Load Stresses in the Columns of a Tall Building, by Clyde T. Morris, 1928.

No. 48, The Design of Tall Building Frames to Resist Wind, by Clyde T. Morris and A. Ward Ross, 1929.

No. 66, Moment-Distribution Method of Structural Analysis Extended to Lateral Loads and Members of Variable Section, by G. E. Large and Clyde T. Morris, 1931.

The tests are being continued by Professors Large and Morris on a model of a 56-story Spurr-designed wind bent, 28 ft. high, constructed of steel (*ENR*, May 17, 1934, p. 637).

Other investigations

Floor-surface materials have been tested by Professor Shank to obtain a scale that architects and engineers may use in selecting and specifying what is to be used on floors and stair treads of

monumental buildings. The test is a modification of the Dorry hardness standard for road stone, 333 revolutions on the wearing surface and use of the cubic centimeters worn off as coefficients.

Azimuth determination, explained and simplified by Prof. E. F. Coddington, is the title of Bulletin 79 published in 1933.

Joints in water pipe are being studied by Prof. John C. Prior, the city of Columbus and the Cast-Iron Pipe Research Association cooperating. The tests indicate flow of lead in joints under stress and initial slip at 50 to 80-lb. pressure when harness is not used.

Foundations for structures are being studied in cooperation with the bureau of bridges of the Ohio department of highways. Karl V. Taylor is investigator under the direction of J. R. Burkey for the department and Prof. C. T. Morris for the university. The studies include piling requirements and admissible soil pressures under footings. A machine has been developed for obtaining specimens and for field determination of length of piling required.

Friction of tires on road surfaces is a project directed by Professors K. W. Stinson and C. P. Roberts. A test car equipped with braking mechanism and recording apparatus is used. Findings given at the December, 1933, meeting of the Highway Research Board (*ENR*, Dec. 14, 1933, p. 721) are: (1) the coefficients of friction on all road surfaces decrease with increase of speed and (2) the difference between the rolling and sliding coefficients increases with increase of speed.

Fillers for brick pavements are being studied in cooperation with the Metropolitan Paving Brick Co., Canton, O. Investigators are Prof. G. A. Bole and Dr. W. C. Rueckel, and the approach is from the side of physical chemistry and ceramics.

The project is not yet far enough along for the announcement of any developments.

JOHN M. W[illegible]
Assistant Director
Engineering Experiment Station
The Ohio State University

Wrought-Iron Fire Stops Installed Below Timber Pier Decks

FIRE STOPS consisting of plates of wrought iron extending from the lower sides of the deck to mean low water were added to the three piers of the Pennsylvania Railroad produce terminal in New York last year as a means of checking the spread of fire below the pier deck. Wrought iron was used because of its high resistance to the corrosive action of salt water.

The Pennsylvania Railroad produce terminal consists of three piers and a headhouse, designated as Piers 27 to 29, on the Hudson River side of Manhattan Island. The structures were built originally more than a quarter of a century ago, but reconstruction of the piers and enlargement of the headhouse were carried out about five years ago. The substructures are entirely of pile and timber construction except for a 10-in. concrete slab on the deck of the piers.

FIRE STOPS of wrought iron have been installed at intervals under the Pennsylvania Railroad produce terminal piers at New York to check the spread of fire below the pier deck.

During the reconstruction work concrete firewalls were carried below the deck of the headhouse, but no firewalls were put below the decks of the piers. These piers are about 75 ft. wide and 700 ft. long, and, together with the headhouse which joins the three piers, extend about 1,000 ft. beyond the pierhead line into the river.

The fire breaks added below the decks of the piers last year consist of diaphragms of ½-in. wrought-iron plates 10x5 ft., lapped 2 in. and bolted with wrought-iron bolts. The plates are inserted along the face of one of the crossbents under the piers and are bolted to the piles of the bent by means of a wale, top and bottom. The upper ends of the plates are cut to fit around the floor stringer, and the joints between the deck and the plates are made tight by means of heavy wooden molding strips.

Four diaphragms have been installed below the deck of each pier, one at the junction between the pier and the headhouse, and three about equally spaced along the length of the pier.

A wrought-iron sprinkler line has been installed below the deck on each side of each diaphragm, and the supply lines are provided with standard fireboat connections in the slips at the side of the piers.

As a further aid in fighting fire below the deck, 10-in. holes have been cut through the deck at frequent intervals to permit the use of cellar fire nozzles. These openings are closed with cast iron caps set flush with the deck.

Contractors and engineers

The cutoff diaphragms were installed by the contracting firm of J. Rich Steers Inc., New York, under the direction of A. C. Watson, chief engineer, New York Zone, Pennsylvania Railroad. The sprinkler system was installed by the Grinnell Co.

Model Laws and Ordinances for Highway Safety

Review of revised and new model laws governing safe operation of motor vehicles on highways approved by the Fourth National Conference on Street and Highway Safety held by the Department of Commerce at Washington, D. C.

A REVISED motor-vehicle code governing registration, certificates of title, licensing of operators and regulation of traffic; two new laws governing financial responsibility and personal liability; a completely rearranged municipal traffic ordinance; and a revised manual of traffic-control devices are presented by the Fourth National Conference on Street and Highway Safety as models for motor-vehicle legislation and regulation. Altogether the new documents include five individual state acts, a municipal ordinance and the traffic-signal manual with a special committee report on traffic safety policies. They are presented as a collective body of codes and laws embracing all phases of motor-vehicle traffic control.

Actual definition of rules for motor-vehicle regulation and operation by national conference sponsored by the U. S. Department of Commerce began with the draft of a uniform vehicle code adopted by the second conference in 1926. This code was prepared in collaboration with the Commissioners on Uniform State Laws. Changing traffic conditions required a more advanced document, and in 1930 the Third National Conference on Street and Highway Safety adopted a revised code. This too was endorsed by the Commissioners on Uniform State Laws and, in addition, by the American Bar Association. The conference also adopted at this time a model municipal traffic ordinance which had been drafted by a special conference committee in 1928. A fact to be noted is that the codes leading to the more inclusive documents now presented bring to it a high character of legal endorsement.

The code and ordinance and coordinate manual and discussion of safety policies now presented are again the result of changing traffic conditions—new developments in the arts of motor vehicle and highway design and traffic control. These developments require a more extended, as well as a thoroughly revised, series of acts and manuals. In general, however, the new documents show few departures in the principles originally laid down; in large measure these have stood the test of some eight years' experience.

A critical question is: How far have these codes and ordinances been embodied in practice? In general, the progress has been substantial. Since 1926 some 34 states have adopted one or more of the acts or have substantially revised their laws to bring them into closer conformance. The revised codes have been drafted to offer more convenient adoption and to include more phases of regulation that modern traffic conditions make it necessary for legislation to consider.

With documents of such length and so filled with details, summary or abstract is impracticable; even review has to be confined to provisions of most striking general interest. These, as classified by the conference committee, are: (1) changes in form, (2) changes in substance, and (3) creation of new regulatory provisions.

Model traffic code

The revised code for states consists of five acts, two of which are new as will be explained later. Four of these acts covering (1) registration, (2) licensing operators, (3) civil liability and (4) financial responsibility have been designated model acts; the fifth act, covering regulation of traffic, has been designated a uniform act. This difference in designation recognizes in the first four acts that it is the substance rather than the exact language that is important, while in the last act effectiveness lies in uniformity of language. A minor change, increasing the clarity of the code and also making it more adaptable, is its break-up into sections confined to a single provision.

Changes in substance relate primarily to operator's licenses, speed limits, driving lights and weight restrictions. In the revised order the operators' license act becomes Act II instead of Act III, the former Acts I and II having been combined. The revised license act is largely original Act III, liberalized to give enforcement officials greater discretionary powers in exercising restrictive and punitive provisions. In effect, the law is made more flexible without lessening effectiveness where rigid control is desired.

Speed restrictions have been freed from much of their uncertainty in the revised code. Recognizing that the recent legislative trend has been unmistakably toward prima-facie speed limits, they are named in the new code as follows: (1) 20 miles an hour in any business district; (2) 25 miles per hour in any residence district; and (3) 45 miles per hour under other conditions. These limits are presented as consistent with present-day safe practice. Provision, however, is made for determining and posting lower limits at points and sections of special hazard. Also local authorities are empowered to post higher limits on through highways, but can in no case violate the basic code rule that: "No person shall drive a vehicle on a highway at a speed greater than is reasonable or prudent under the conditions then existing."

Similarly the revised code recognizes new conditions in driving-lights practice. Primarily the provisions of the revised code are based on the use of multiple-beam head lamps, while recognizing the still extensive use of single-beam lamps—but under specific restrictions as to projection limits and light intensity. Single-distribution lights are legally allowed on all "motor vehicles manufactured and sold prior to Jan. 1, 1936." Principally, as stated, the provisions of the revised code are directed toward the control of multiple-beam lighting and are elaborate and definite in respect to intensity, limits of beam distribution and operation of the beams when traveling. In respect to other than headlights the old code provisions stand as a whole but with changes for clarity and precision.

In vehicle clearances and axle loads the requirements of the Association of State Highway Officials are adopted substantially in full. Limiting widths are 8 ft., except 10 ft. for farm tractors and 8½ ft. for trucks on which pneumatic tires have been substituted for older and narrower tires. The maximum clearance height is set at 12½ ft.; the maximum length for one vehicle at 35 ft., tractor-truck and semi-trailer to be regarded as one vehicle. Coupled vehicles are limited to two units of no greater total length than 45 ft., except in case of certain day-time haulage of poles, pipe or other long units. Wheel loads are the standard A.A.S.H.O. 8,000 and 9,000 lb., with axle loads of double these figures.

The code committee has not reached agreement relative to suitable treatment of allowable gross vehicle weights. A special subcommittee, requested to prepare text covering the subject for further consideration by the main committee at its meeting May 22, submitted the following, with respect to the merits of which the members of the subcommittee were divided and made two reports, one favoring and one in opposition.

1. The gross weight of any vehicle having two axles shall not exceed either the sum of the two allowable axle weights or the gross weight dependent upon length as given in the table, whichever is lower.

2. The gross weight of any vehicle or combination of vehicles having three or

more axles shall not exceed the sum of the allowable axle weights or the gross weight dependent upon length as given in the table, whichever is lower.

Length, ft.*	Max. Gross Wgt., Lb.	Length, ft.*	Max. Gross Wgt., Lb.
10	35,000	26	46,200
12	36,400	28	47,600
14	37,800	30	49,000
16	39,200	32	50,400
18	40,600	34	51,800
20	42,000	36	53,200
22	43,600	38	54,600
24	44,800	40	56,000

*Between centers of first and last axle.

The above table of maximum gross weights is derived from the formula 700 (L + 40), adopted by the American Association of State Highway Officials as a method of protecting bridges from excessive loads. In this formula *L* equals the length in feet between centers of first and last axles of a vehicle or combination of vehicles. The coefficient of 700 has been recommended by the American Association of State Highway Officials as the lowest which should be imposed for traffic on all main rural and intercity roads, for the reason that bridges on such roads, with few exceptions, have been designed for loads at least as heavy as those given by the formula with that coefficient. In the few cases of bridges designed for lighter loads, protection against unsafe overloading can be afforded by posting.

As stated, the revised code contains two new acts: Act III, covering personal liability; and Act IV, covering financial responsibility. The last-mentioned act is based upon the safety responsibility bill sponsored by the American Automobile Association, requiring the satisfying of any outstanding judgment resulting from a motor-vehicle accident, and proof of financial responsibility, as conditions to the retention of the vehicle registration and operator's license of any person found at fault in a serious traffic accident or convicted of a major violation.

Civil liability provisions at various points in the present code have been brought together, and certain other provisions have been added to form a new model act relating to civil liability of owners and operators of motor vehicles.

Municipal traffic ordinance

In the present revision the model municipal traffic ordinance has been completely rearranged to facilitate its direct use. As presented, it differentiates between (1) local traffic regulations not suitable for state legislation and (2) basic rules of the road, which should be covered by uniform state law provisions. The former are presented in full in the ordinance proper, with the suggestion that each municipality select the provisions suited to its needs. The latter are indicated in the ordinance proper by title only, with reference to their full text in an appendix. It is pointed out that these rules of the road must be operative and enforceable in the community as elsewhere, and should be included in the ordinance if necessary to accomplish this.

Besides the report of the committee on uniform traffic laws and ordinances which has been reviewed, two other committees presented reports. One of these is a manual on traffic-control devices, which is a consolidation of the present rural and city manuals for signs and signals. The other is a general report on traffic-safety policies, emphasizing the relation of legislation, administration, engineering, education and enforcement as essential elements in bringing about efficient and safe use of the country's network of highways and streets.

The *Manual on Uniform Traffic-Control Devices* is a revision and consolidation of two previous manuals—that of the American Association of State Highway Officials for rural highways and that prepared by the American Engineering Council for the National Conference on Street and Highway Safety to apply to city streets. The new manual covers all of the subject matter of both of the other two and expands the treatment of islands (heretofore confined to safety zones for car riders and other pedestrians) to embrace traffic islands as well. It also presents much new matter, particularly with reference to the conditions warranting traffic signals, their design, operation and maintenance, and details of island design and protection.

The new manual is in strict harmony with the uniform vehicle code and model municipal traffic ordinance. It also takes into account the recommendation of the Sixth International Road Congress, held in Washington in 1930, that consideration be given to the more extensive use of symbols. The joint committee, while believing that, on a great majority of signs, symbols cannot safely replace word messages, sees very definite advantages in certain simple symbols, such as those for curves, and has eliminated the former word message from CURVE signs.

The committee recommends night illumination of the outlines of stop and slow warning signs, and believes the general use of such illumination will tend to make motorists conscious of the meaning of the shapes of such signs and instinctively obedient to them.

Recent extensive tests by the National Bureau of Standards in cooperation with the U. S. Bureau of Public Roads of color combinations for signs under a wide variety of conditions have confirmed the previous belief that a yellow background and black message provide the best possible color combination. It is therefore used for the stop and warning signs.

Intersections are considered the most critical points in traffic control, and a large percentage of the control devices in this manual relate to intersections. Accurate determination of the degree of control needed at an intersection is held highly important, as is proper selection of the design and operation details to effect that degree of control. It is believed that at many intersections no artificial control whatever is desirable; larger volumes of traffic, however, or special characteristics, such as obstructed view or heavy grades, make some form of control advisable, but the devices that will serve the purpose with the least inconvenience to traffic should be used. The normal progression is as follows: (1) a caution-type sign, (2) a slow-type sign, (3) a stop sign, (4) a traffic-control signal installation, (5) a rotary traffic development, and (6) a grade separation.

For the first three of the foregoing, simple standards are provided; if the situation calls for any of the last three, careful study of the details of design and operation is urged. The two major objectives are safety to vehicles and pedestrians, and the expediting of traffic; these two considerations are sometimes antagonistic, in that an extreme degree of control might increase safety to some extent but at the same time retard traffic too much for sound economic operation. In such cases a balance must usually be attained between these two factors, frequently with some modification due to installation cost.

Adequate but not excessive use of signs to warn of hazards, signs to indicate the applicability of traffic regulations, route markers and destination signs are held to have great value in facilitating the orderly flow of traffic, as do well-considered pavement and curb markings and islands properly designed and located, but application of sound principles in the selection, installation and operation of traffic signals is considered of the highest importance. Misapplication of these traffic-control devices, besides wasting public funds, has in numerous cases accomplished the reverse of the purpose intended, causing delay and confusion and promoting disrespect for and disregard of all control devices.

In many communities it is pointed out that the responsible authorities have not met the problem with scientific analysis but rather by haphazard experimentation, and as a result two fundamental errors have been prevalent. These are: (1) placing traffic-control devices without adequate study of the possible evil effects produced either there or at other points; and (2) in the case of traffic signals, operation at times is not justified by the conditions.

Traffic-control requirements in any specific case, it is stated, cannot be determined by guesswork. They should be based on sound engineering principles established by factual studies of accidents, speeds, delays and physical conditions which will show the exact nature of the difficulty and indicate what particular device or method of control is needed.

Letters to the Editor

Wages of Capital

Sir—In your issue of March 22, 1934, you refer to the claim of the railway labor groups in their argument with the railways over continuing the 10 per cent wage cut now in force. You argue that capital gets its wages even in time of depression, while labor hire is controlled by what is left; and through this wage discrimination in the case of railway workers, the large majority are forced down into the class of "lowest income-workers." You also state that many thousands of veteran workers are thrown out of employment during a depression, to go on relief or starve, while the employment of capital continues throughout and its wages are kept at peak level.

There is reason to feel that capital in some forms of investment should share more fully than it now does in the results of depression. But it is not true that the employment of capital continued throughout recent years and its wages were kept at peak level. The statement is true in so far as it applies to those railways that were able to pay bond interest. But not all of them could do this. Interest or principal or both were defaulted by 35 in 1931; 46 did the same thing in 1932, and 50 in 1933. Numbers of small railways and several of the large and important systems are in receivers' hands, with consequent losses to capital. Labor has not been the only sufferer from the depression.

In connection with the claim of the railway labor groups, it should be remembered that every owner of an insurance policy, of a home or an equity in a home, or of a savings-bank account is to that extent a capitalist. Great numbers of those same railway workers who complain about the wages of capital are themselves capitalists in the above respect and are benefited when capital does get its wages.

But the question of whether capital should receive a fixed rate of return rests upon broader grounds than the relative positions of capital and labor. The interest of society as a whole is of far greater importance.

The idea of bonds with a fixed rate of return is so firmly placed in our laws and in our mental attitude it is difficult to get away from it. It is hard for most of us to think that stocks can be as safe as bonds. But many corporations have concluded that stocks can be safe and are acting on that conclusion, to the benefit of themselves and their stockholders. A bond is not safe simply because it is backed by physical assets if the project is over-financed, or if management is unable to make those assets continue to pay a profit. The safety of an investment rests upon the integrity and ability of management, not upon the name by which the securities are called.

In the case of defaults on bonds, the result is reorganization, receivership or bankruptcy. In every such case there is a loss of capital.

The records of a well-known statistical company show that in 1926, which has been assumed to have been a year of standard prosperity, there were but 63 defaults. In 1931 there were 836 defaults in interest or principal or both. In 1932 there were 986, and in 1933 they dropped to 588. These figures are for the United States, and in compiling them I have omitted all defaults where the information available indicates that reorganizations have been successfully made. The total amount of capital involved in defaults in the above years was as follows:

1926	$ 60,493,250
1931	1,415,318,220
1932	2,028,586,920
1933	2,350,122,866

Compare the standard year 1926 with the depression years 1931, '32 and '33.

No one can tell how much of this capital will be finally lost to the investors, but the amount is very great. The country would have been far better off if the reorganization and receivership expenses that have been incurred could have been saved and if those corporations that went into bankruptcy could have been kept going—and the majority of them could if they had had no bonds—with the resulting saving in capital and with the saving of the intangible but immensely valuable good will which they possessed and which is now a complete loss.

We cannot change the capital structure of the country to a stock basis all at once, even if it were agreed that this is desirable. And many will not so agree. The habits of the investor will have to be revised before such a change in securities can become general. But styles in investments change as they do in clothes, and it can be done. When the investor feels that stocks are safe and that his chance for profit in them is greater than in bonds he will take them. And when he feels that way the greater expense of selling stocks, which now is often claimed, will disappear.

No doubt changes in laws will be needed to make such a change effective, even in the field of railway and corporate financing. And before it can be applied to governmental financing, great changes will be necessary.

I believe that a change from bonds toward stocks is not only desirable for the economic advantage of society as a whole but that it is under way.

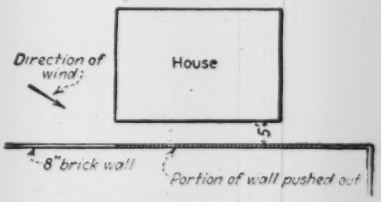
We as engineers have paid too little attention to questions of this sort. We have devoted most of our energies to the problems of design and construction and have brought about great physical improvements. We can go farther than this. We should not only design and build physical structures, but we should take our part in the designing of the financial structures without which the physical ones cannot be built.

Chicago, Ill., April 27, 1934. LOUIS J. HOTCHKISS.

Effect of Buildings on Wind Pressure

Sir—In connection with the note "Wind Studies on Building Model Show Effect of Neighboring Structures" (*ENR*, March 8, 1934, p. 327) perhaps the following brief account may be of interest:

Several years ago in this city an 8-in. brick wall of a one-story building collapsed during a violent wind storm. A detailed investigation of the disaster, and subsequent study, revealed some interesting facts. The accompanying sketch is intended to illustrate what occurred and the contributing causes. The



LAYOUT of house and brick wall. Wind entering channel between the two increased in velocity and caused a reduction in pressure below atmospheric. Wall and house moved toward one another.

wind, of high velocity—in reality of tornado magnitude—came from the northwest and entered the narrow channel, which was about 5 ft. wide, between the buildings. In passing through this channel the velocity increased, which caused a drop in pressure, below the normal atmospheric pressure, between the buildings. This resulted in the destruction of the brick wall outward and the breaking out of the windows in the house and a movement of the house on its foundation toward the brick building.

This occurrence was so unusual that the writer constructed a crude model, not to scale, to demonstrate the principle involved. Air velocities up to 40 m.p.h. were available in the laboratory, and a substantial drop in pressure, below atmospheric, was observed in the channel between the walls. Obviously, it would be difficult to apply quantitative measurements on such a model to the actual buildings. The phenomenon was present, however, as expected from theoretical considerations, and forms a complete explanation of the cause of the disaster.

I. F. MORRISON,
Professor of Applied Mechanics,
University of Alberta.

Edmonton, Alberta,
March 23, 1934.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

Concrete Marine Structures

CONCRETE STRUCTURES IN MARINE WORK—By R. Stroyer. Fabrikoid; 6x9 in.; pp. 216; photographs, diagrams and tables. Published by Knapp, Drewett & Sons, London. 15s.

Details of a large number of marine structures, retaining walls, wharfs, piers, breakwaters and moles are given in this small but profusely illustrated book. Except for the introductory discussion of materials for marine work, the book deals entirely with concrete structures, principally in Europe. There is included also a discussion of the theory of retaining walls, chiefly as it relates to wharves, also a discussion of the theory of the carrying capacity of piles.

Railroad History in Brief

TRAINS—By Robert Selph Henry. Cloth; 9x13 in.; pp. 105; photographs. Published by The Bobbs-Merrill Co., Indianapolis. $2.50.

The history of American railroad development is concisely summarized in this book of a little over 100 large-sized pages. There also is included a fair amount of information concerning railroad operation, signaling, motive power, rolling stock and fixed structures. A considerable part of the sections on motive power and rolling stock is given over to modern railroad equipment, including the light-weight trains of the Union Pacific and Burlington. The author is a railroad man with an unusual facility in description. Begun as the basis of talks on trains before a boys' school in Georgia, the book has developed into one of interest to grown-ups as well as boys. It is profusely illustrated with well-chosen pictures.

A Preview of Engineering

BUILDING AN ENGINEERING CAREER—By C. C. Williams. Cloth; 6x9 in.; pp. 247; numerous diagrams and half-tone illustrations. Published by McGraw-Hill Book Co., Inc., New York and London. Price $2.

Dean Williams, in this book, attempts to give to the student entering upon an engineering course a preview of the several fields of engineering to aid him in orienting himself as he enters his profession. The book is an outgrowth of a course of orientation and motivation conducted by Dean Williams during the past six years. It outlines the principal elements of engineering work and the achievements in the major fields of engineering. Engineers long past the student stage will read Dean Williams' discussion of the profession of engineering with considerable interest.

British Concrete Practice

NOTES ON CEMENT AND REINFORCED CONCRETE—Prepared by an unnamed author for the Ketton Portland Cement Co., Ltd. Cloth; 6x9 in.; pp. 236; numerous diagrams, tables and half-tone illustrations. Published by Sir W. C. Leng & Co., London and Sheffield. Price 7s. 6 d.

REINFORCED-CONCRETE ARCH DESIGN—By G. P. Manning. Cloth; 6x9 in. pp. 190; numerous diagrams and half-tone illustrations. Published by Sir Isaac Pitman & Sons, London, and Pitman Publishing Corp., New York. Price $3.75, or 7s. 6d.

Both these small books reflect British practice in reinforced-concrete design but otherwise are quite dissimilar. The first is elementary and of handbook character, while the one on arches will be useful only for advanced students. "Notes on Cement and Reinforced Concrete" is sponsored by the Ketton Portland Cement Co. and is notable for about a dozen design examples of various types of members or structures. The remainder of the book is devoted to consideration of materials, loads, stresses and cement manufacture.

The book on arches is intended for the use of designers. Each chapter is devoted to design considerations for a different type of arch. One of its important features is a listing of values of influence lines for a wide range of arches of different shapes and thicknesses. Slope-deflection methods are generally used, although an energy method is used for the flexible arch.

A Fifty-Year Record

THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS—The History of the First Fifty Years, 1884-1934. Paper; 6x9 in.; pp. 118; photographic illustrations. Compiled by Charles Rufus Harte.

A storm of unusual severity that swept the North Atlantic States in late February of this year seriously interfered with, and drew attention from, an event of no little interest to the engineering profession, the celebration of the fiftieth anniversary of the Connecticut Society of Civil Engineers. Fortunately for those who were unable to attend the semi-centennial celebration, a record of the society's 50 years of service has been compiled from its annual *Proceedings* in the booklet that is the subject of this comment. It is written in the concise and easily readable style that is characteristic of the compiler, Charles Rufus Harte. The society has been a virile one throughout the entire half-century of its existence, possibly because it has adhered to the admonition of its first president that its papers and actions be of "practical import rather than learned theoretical disquisitions." Bradley H. Hull, founder and first president, considered the function of a state society to be that of concentrating engineering thought on state and local questions of engineering interest, transportation, sanitation, public safety and the like. The record, as compiled by Mr. Harte, is one of frequent action by the society on such matters, much of it being taken at a time when many engineers questioned the propriety of engineering societies expressing an opinion on public affairs. The fact that today public officials accord weight to the society's views and pronouncements is probably to be credited both to its basic policy and its record of activity.

Steel Construction

STEEL CONSTRUCTION—Second Edition. Fabrikoid; 6x9 in.; pp. 352; tables and diagrams. Published by the American Institution of Steel Construction, New York City. $2.

COMPLETE REVISION and major recasting characterize the second edition of the Manual of Steel Construction so well known to structural engineers, architects and builders of steel structures. As contrasted with the first edition, it is larger in size, different in typography and more varied in content, with emphasis placed in accordance with the dictates of ten years of experience. The new edition, considered desirable for some time, became imperative when the mills which produce the popular wide-flanged shapes announced a new and completely standardized series.

So far as possible, the contents of the new book have been arranged for the convenience of the estimator, designer and detailer, without regard to usually accepted academic classifications. Thus, Part I is devoted to data used in proportioning steel members after the forces to be resisted have been determined. Part II is detailed information, Part III allowable loads, Part IV specifications and codes, and Part V miscellaneous data. The latter has been much abbreviated from the first edition in accordance with the opinion of a majority of the members of the large advisory committee of engineers who helped with the new edition. Data from the first edition on history of iron and steel, physical and chemical properties, manufacturing practices, elementary discussion of loads and stresses, trigonometric functions, steel windows, etc., are not included in the new edition.

On the other hand, there are included some 30 new items, about half of which

have never been published before. Included among the latter are standard designations for rolled-steel sections on drawings, tables of available sizes of plates and of sizes, and section moduli of bearing plates, tables of cambering for wide-flange (*WF*) sections, tables of tolerances, tables of economy for selection of beam sections, design data for plate girders, for beam-bearing plates and column-base plates, corrugated sheet-metal construction data, general detailing practice and standard beam connections.

Miscellaneous Notes on Booklets and Reprints

WATER CONSUMPTION AND METERING IN PHILADELPHIA is the subject of a paper published by the Bureau of Municipal Research, Social Service Building, Philadelphia, Pa.

THE CAUSE AND PREVENTION of Calcium Sulphate Scale in Steam Boilers—Bulletin No. 261, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 85c.

SURFACE SHALES AND CLAYS OF OHIO: A preliminary report on physical tests and properties. Engineering Experiment Station, Bulletin No. 81, Ohio State University, Columbus, Ohio. Price, 50c.

A HISTORY OF LAND SURVEYING in South Carolina is contained in Land Surveys in South Carolina, Bulletin No. 2, Engineering Experiment Station, Clemson Agricultural College, Clemson College, S. C.

A LIST OF TOLL BRIDGES in the United States with their owners is included in Vol. 2 of the 1934 *Proceedings* of the American Toll Bridge Association, 1024 Vermont Ave., Washington, D. C. The *Proceedings* also includes numerous papers on toll-bridge operation. Price, $1.

THE ACTION OF WATER ON LEAD, with special reference to drinking water, is discussed in Technical Paper No. 4, Water Pollution Research of the Department of Scientific and Industrial Research, Great Britain. The paper is a summary of existing knowledge. It is published by His Majesty's Stationery Office, London. Price 2s.

CONSTRUCTION COSTS—1910-1933, 1934 EDITION. Statistical information on construction costs and volume, index numbers of construction costs, wage rates, materials prices and unit bid prices. New features in this year's edition are a study of apartment-building costs; construction costs of six skyscraper office buildings analyzed and repriced at current rates; and post office construction costs analyzed by subtrades for both cube costs and percentage of total cost. For convenience in analyzing current price changes the *Engineering News-Record* cost and volume index has been converted to a 1926 = 100 base. The Lambert utility index figures are given on a monthly basis for the first time. Published by *Engineering News-Record*, 330 W. 42d St., New York City. Price, $1.

STREAMFLOW RECORDS OF PENNSYLVANIA have been issued in a new form, four years' records being combined in a single volume covering the period Oct. 1, 1928, to Sept. 30, 1932. They are published by the Water Resources Service of the Department of Forests and Waters, presumably at Harrisburg, Pa.

MUNICIPAL ELECTRIC PLANT MANAGERS is the subject of Publication No. 38, Public Administration Service, 850 East 58th St., Chicago. The pamphlet deals with the selection, training, salaries and tenure of office of plant managers. It also contains a list of municipally owned electric-light plants in the United States. Price 60c.

MEASURING THE ENGINEERING STUDENT, Some Recent Advances in the Selection of Raw Recruits, is the subject of a single paper in the first issue of "Journal of Engineering Educational Research," published by Prof. Clair V. Mann, University of Missouri, Rolla, Mo. (Price 50c.) The journal is printed by aid of Engineering Foundation.

SEA-WATER ACTION ON IRON AND STEEL specimens and on concrete piles is outlined in the fourteenth interim report of a committee of the Institution of Civil Engineers (London) entitled "Deterioration of Structures in Sea Water." The price is 1s. 6d from the Department of Scientific and Industrial Research, 16 Old Queen St., Westminster S.W. 1.

RECOMMENDATIONS RELATING TO TRANSPORTATION are contained in a pamphlet published by the Transportation Conference of 1933-34 (First National Bank Building, Chicago). The conference is composed of representatives of fifteen national organizations interested in railroad operations, including security owners, shippers, bankers and railroad executives.

REDUCTION OF NOISE IN BUILDINGS is the subject of a small pamphlet published by H. M. Stationery Office, London. It contains recommendations to architects based on data obtained from research made at the laboratories of the Building Research Board at Garston, Wadford, England. A large part of the report is in the form of illustrated tables showing the relative effect of structure on the insulation or prevention of sound. It also contains recommendations on the reduction of equipment noises, and concludes with a bibliography of literature on the subject treated. Copies may be obtained in this country from the British Library of Information, 270 Madison Ave., New York City, price 9d. (about 23 cents).

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

BETON-UND EISENBETONLEITUNGEN—By Erwin Marquardt. Paper; 7x11 in.; pp. 99; photographs and line drawings. Published by Wilhelm Ernst & Sohn, Berlin. 10RM.

THE DESIGN AND USE OF INSTRUMENTS AND ACCURATE MECHANISM, UNDERLYING PRINCIPALS.—By T. N. Whitehead. Cloth; 6x9; pp. 283; diagrams and half-tone illustrations. Published by The MacMillan Co., New York and London. Price $3.50.

ELASTICITY, STRUCTURE AND STRENGTH OF MATERIALS USED IN ENGINEERING CONSTRUCTION — By C. A. P. Turner. Cloth; 6x9 in.; pp. 416; photographs, diagrams and tables. Published by the author, Builders Exchange, Minneapolis. $6.

GOVERNMENT AND TECHNOLOGY—By William Beard. Cloth; 5x8 in.; pp. 599; photographs. Published by The Macmillan Co., New York City. $3.75.

A HANDBOOK OF NRA—Second Edition; Edited by Lewis Mayers. Cloth; 6x9 in.; pp. 842. Published by Federal Codes, Inc. 32 Union Square, New York City. $6.50; with semi-monthly supplement service, $10. . . . *Codes approved in 1933 with an analysis of legislative acts, executive orders, rulings of NRA and court decisions. Nothing on the construction industry codes.*

HELPS TO SUCCESSFUL CONTRACTING—By Harry O. Locher. Cloth; 5x8 in.; pp. 222 Published by McGraw-Hill Book Co., Inc., New York City. $2.00.

ADOLF HITLER-BRUCKE, KOBLENZ—Board; 10x12 in.; pp. 58; photographs and line drawings. Published by Wilhelm Ernst & Sohn, Berlin. . . . *A description of a reinforced-concrete arch bridge at Koblenz named for Chancellor Hitler.*

INDIAN FOREST RECORDS: THE PHYSICAL PROPERTIES OF WOODS GROWN IN INDIA, THIRD INTERIM REPORT—By V. D. Limaye. Cloth; 7x10; pp. 70; numerous tables. Published by the Forest Research Institute, Dehra Dun, U. P., India. Price 7s.

THE MUNICIPAL YEAR BOOK, 1934—Clarence E. Ridley and Orin F. Nolting. Cloth; 7x10 in.; pp. 256; tables. Published by International City Managers' Association, Chicago. $4. . . . *In publishing this year book the International City Managers Association begins the enlargements of the scope of the City Managers' Year Book, published since 1914.*

PRACTICAL FORMS IN EXPOSITION—By Harlow C. Richardson, Luther N. Becklund, Ledru O. Guthrie, Clifford I. Haga. Cloth; 6x9 in.; pp. 429; diagrams and tables. Published by The Macmillan Co., New York City. $2. . . . *A manual for technical students to assist them in the preparation of papers, letters and reports.*

RESULTS OF MUNICIPAL LIGHTING PLANTS—By C. F. Lambert. Third edition. Paper; 6x9 in.; pp. 139; charts and tables. Published by Burns & McDonnell Engineering Co., Kansas City, Mo. $1. . . . *Electric rates in 363 cities and towns are given in this edition.*

WATER SUPPLY ORGANIZATION IN THE CHICAGO REGION—By Max R. White. Cloth; 6x8 in.; pp. 170; tables. Published by The University of Chicago Press. $2.

ENGINEERING NEWS-RECORD

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard, W. W. De Berard, N. A. Bowers.

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May 24, 1934

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Municipal Water Rates

AN INTERESTING OPINION by the Pennsylvania supreme court on rates to be charged by the municipal waterworks at Lancaster definitely increases the administrative powers of waterworks management. The city recently raised its water rates to produce enough revenue to pay for the cost of a sewage-treatment plant. In a case brought by a protesting consumer the lower court held the new water rates to be unreasonable in that they would produce a profit. The supreme court has reversed this finding. In its opinion remitting the case for rehearing, the court holds that there is no legal ground on which a municipal utility may be enjoined from earning a profit, and that a reasonable rate for such a utility should be determined in the same way that a rate is established for a utility privately owned. The opinion is clearly progressive, as it overthrows the doctrine of fettering municipal operations with narrow, unbusinesslike restrictions. On the other hand, it leaves unanswered the question of whether water and sewer service may be linked together as a single utility.

By Way of Modernization

WITH REVIVAL of world commerce it is certain that there will be increased development of port facilities. What form is it likely to take? Present evidence points to modernization and enlargement of existing ports as more logical than the creation of new ports. Particularly in Europe, maritime authorities are coming to the conclusion that there may be too many ports, that new ones serve mainly to take business from others better able to meet the demands of commerce. The port of Havre, described in this issue, presents an instance of expansion and improvement that is notable especially because of the obstacles that had to be overcome, since new docks and terminals could be provided only by extending an open ocean beach out to sea. Here, if anywhere, a new port location affording easier harbor construction might have been thought desirable, yet the choice was for modernization and extension. Considering the assets of good will and property investment that are preserved, the choice was undoubtedly wise. The Havre enterprise is an instructive model also because it is built around the principle that port works are a mechanism for the interchange of traffic.

Accident Habituals

ACCIDENT-PRONE DRIVERS represent a serious highway hazard and form a rather hopeless problem, according to investigations recently made by the National Research Council's committee on the psychology of the highway. The study was centered on commercial drivers and was conducted by a utility company that operates a large fleet of cars. Briefly, the study showed that there was a group of drivers who contributed most of the accidents, that special training and instruction did not materially improve their records, and that when they were transferred to other work their personal accident frequency was greater than that of other workers. While these are but a few of the impressive charges against accident-prone drivers contained in the study, they are sufficient to emphasize a fact too often slurred, even in the face of accident records—namely, that control of highway hazards must reach beyond safe road structure and skillful planning of light and sign signals. Of late these physical conditions and mechanical precautions have been accused of being the prime causes of accident—and from the standpoint of the designing and construction engineer they should be so regarded. But after granting that road conditions and traffic signals require radical correction, we ought also to recognize that the fitness of the individual for driving is an important element of safety, and that the unfit should be barred from the road.

Modernizing the "El"

LIGHT-WEIGHT railway car construction finds an application of special value in elevated railway service, as in the case of the articulated units just completed for the Brooklyn-Manhattan Transit lines in New York. The elevated lines were built before the day of the heavy motor-driven steel car; their structures were designed to carry a light-weight locomotive and light wooden cars. Even with motors added, the old cars are not efficient enough for present demands, and they involve a considerable accident hazard. Steel cars of the ordinary subway type are too heavy for the elevated structure. Hence the research of the B.M.T. engineers that has led to the design of the light-weight cars now about to be put into service. Two articulated units have been built, one of structural aluminum and one of thin alloy-steel shapes built up by the "shot-welding" process, similar in this respect to the new trains of the Union Pacific and Burlington railroads. The saving in weight made possible by the use of these substitutes for ordinary steel framework is expected to make possible the modernization of the elevated lines to a point where their service and safety standards will equal those of the later subways.

Wind-Erosion Hazards

IN THE PHENOMENA of the remarkable dust storms that swept the country from the Great Plains to the Atlantic Coast in the early days of the month, reviewed in an interesting report by H. H. Bennett, director of the new Soil Erosion Service, the destructive possibilities of wind erosion are brought to attention in a way that challenges the consideration of all thoughtful men. Mr. Bennett definitely states that the "soil fog" that swept over the eastern states came from the drought-stricken areas beyond the Mississippi. He traces the dust storms back to the latter part of 1932; since then, he reports, soil drifting has damaged a large area of grain lands throughout the middle plains region, the action reaching greatest severity last month. The cause of the destructive action is found to lie in the cultivation of the land and to require agricultural methods for its control. Yet the relation of the phenomenon to engineering operations and methods may still prove to be worth study. Water erosion of agricultural lands is well recognized as being in large part an engineering problem with respect to correction and cure; wind erosion also may be amendable to preventive engineering operations.

Back to Relief?

A YEAR AGO the public-works recovery campaign was being shaped for action. "Adoption of the government's plan," we then said, "means definite departure from the charity-relief philosophy that has held our public life in its grip for the past few years." Yet, now, after half-hearted trial of the plan for eleven months, it is being abandoned.

The President has placed before Congress a budget of emergency operations from which public works are virtually excluded. A small indeterminate amount is provided for continuing the works program, but the request for executive discretion to withdraw emergency expenditures in favor of relief emphasizes the purpose to abandon constructive action and fall back on relief. This in spite of the fact that eight millions are still looking for work, and that great numbers of needed improvement projects are waiting to utilize this vast labor resource in productive activity.

Return to relief is the plain meaning of the program. Congress, in interpreting it, will have the full responsibility of deciding whether the country shall go back to relief. Its members know the meaning of re-employment in its social effects and in its influence upon recovery; they know the destruction of private and public morale that resulted from the past year's public charity; and they know also the vast extent of improvement and development work still waiting to be done.

The program as submitted to Congress is not final, but temporizes. The emergency appropriation is intended to run to January only, after which a new Congress may provide for further needs. By that time, however, public enthusiasm will be gone and project plans will be dead. Only the forethought and planning of local officials to continue their project development and make ready for quickly resumed construction can avoid this unfortunate result.

Discontinuance of the public works program will also make it impossible to correct one serious defect of the $3,300,000,000 program—the failure to concentrate projects where unemployment is greatest. Under a continued program wiser planning of allocations could have been attempted, and a more direct remedial influence on unemployment might have been produced. That prospect, too, is now in danger of disappearing, unless Congress, seeing the unemployment need in its true proportions, decides to amend the budget plan.

Stabilized Soil Roads

IMPROVED TECHNIQUE in building roads of natural soils is being developed. By aid of the new science of soil physics, research engineers find that stable road building combinations may be produced from most of the common soils. One of the most thorough of the research activities is described in a series of four articles beginning in this issue. Its results promise to extend materially the range of construction processes available for secondary roads.

In the light of present knowledge, stabilized soil construction may be expected to find chief use in connection with subgrades; and this is of high importance, for a stable foundation is the first requisite of every road. Again, the prime function of the method is to improve the local soils by giving them increased structural integrity through water control and the addition of lacking elements of stability. Bulk replacement of local by non-local materials will probably be worth consideration only in exceptional cases.

Most efficient application of soil stabilization requires that it be looked upon not as a final end but as an intermediate step toward further road improvement. This means, for one thing, proper drainage and transverse profile; they are obviously indispensable wherever the road is to serve as foundation for a later high-type surface, but they are hardly less essential even where traffic for years will have to depend on the soil surface alone. Accordingly, sound road planning—as exemplified in the roads of Onondaga County, N. Y., (*ENR*, Nov. 2, 1933, p. 529) and the Michigan roads illustrated in this and succeeding issues—is characterized by definite recognition of the stage-construction principle.

Fortunately for its further development, stabilized-soil road construction is in a position to avoid the trial-and-error period that most road processes have gone through. Research in this instance has preceded rather than followed upon extensive field use, a condition that greatly favors intelligent advance. It represents a gain that ought not be jeopardized by unrestricted promotion.

Certificates of Merit

THIS TIME OF YEAR, being perennially associated with diplomas and similar awards for achievement, recalls that there are others than university students who deserve a certificate of merit. No four-year grind in college can have been more replete with periods of hope, despair and hard work than the past four years in the construction business. And, what is sometimes forgotten, there has been achievement of a high order in improving the construction art. Think back a short time. The road we have come was never more plainly marked with active new thinking.

To recall a few specific instances: The pages of this journal have recorded within recent weeks notable progress in the application of vibration to concrete pavements, in the utilization of equipment for eliminating rock-drilling silicosis, in the improvement of design and construction practices to cope with earthquake forces. Last week a new quantitative study of building frames was reported. The present issue begins a series of articles telling of significant research into the possibilities of stabilized earth roads. Soon the creation of new revetment types on the Mississippi will be described.

Within six months, pumping as a medium of concrete distribution has emerged as a practical improvement applied extensively to buildings, dams, bridges and locks. Cement-macadam roads have been resurrected from the dead and adapted to modern traffic. The science of soil action in all its complexities has been applied by means of searching tests to the design of a remarkable retaining wall. In these instances and many others technical achievement of high order is readily recognized.

Prominent in many of these advances is the part played by the manufacturers of equipment and materials. And, in thinking back, let us bear in mind that these organizations have made their contributions not in superficial claims but in careful research and cooperative action with engineers and constructors alike. With the whole industry working together thus progressively, it is clear that there is no ground for a doubtful attitude concerning the virility of technical achievement

CURRENT NEWS

Appeals Board for Construction Code is Organized

AT THE organization meeting of the Construction Appeals Board in Washington, May 18, the entire nine members were present and selected the following officers: Wilson T. Ballard (engineering member) chairman, John W. Cowper (general contractor member) vice-chairman and J. W. Follin, secretary of the Construction Code Authority, Inc., secretary. Hayes and Hayes, counsel for the Construction Code Authority, were appointed counsel for the board. Membership of the board was reported *ENR*, May 10, p. 616.

The board is preparing rules of procedure and practice which will be approved at its next meeting, June 8, and then released to the divisions of the industry to govern appeals made from divisional code authority decisions, or complaints regarding conflicts between provisions of the various chapters of the code. Offices of the appeals board will be at the headquarters of the Construction Code Authority, 1114 National Press Building, Washington, D. C.

Executive director appointed

Col. B. R. Value, formerly deputy administrator for NRA in charge of the Construction Section, has been appointed executive director of the Construction Code Authority, effective May 16. Colonel Value, who has had extensive experience in construction work, joined the staff under Deputy Administrator Malcolm Pirnie in October, 1933, and was promoted to deputy administrator early this year when Mr. Pirnie resigned. All of the present chapters of the Construction Code received final approval during his régime.

Major Robert N. Campbell, formerly one of the assistant deputy administrators to Colonel Value, has been appointed deputy administrator in charge of the Construction Section.

Hearing on sub-chapters

On May 21 a public hearing was held on three proposed sub-chapters to Chapter II, the general contractors division, covering respectively (1) II-A, Building Contracting Sub-division; (2) II-B, Heavy Construction and Railroad Contracting Sub-division, and (3) II-C, Highway Contracting Sub-division. A few objections were raised to the proposed revisions submitted. The public hearing was adjourned for three weeks, subject to the call of the administrator. It is expected, however, that this is only part of the routine procedure in order that the hearing may be reopened for any additional information, if necessary.

The President approved May 18 a separate code for River and Harbor Improvement, embodying principally dredging work.

On May 15 the President approved Chapter X of the Construction Code covering the plumbing contracting division. This chapter becomes effective on June 4. This is the second divisional chapter to incorporate skilled labor rates, and includes hourly wages of $1.00, $1.10 and $1.20 for skilled labor respectively in the Southern, Central and Northern zones which are identical with the rates and the zones established under PWA. Unskilled labor will be paid a minimum of 40c., 45c. and 50c., respectively in the three zones.

The divisional code authority to be established under this chapter comprises thirteen members, seven to be elected by the board of directors of the National Association of Master Plumbers, from its membership; three by the same board from non-members of the Association; and three members appointed annually by the United Association of Journeyman Plumbers and Steamfitters.

This chapter covers the repairing or installing, for profit or hire, of all types of plumbing equipment and fixtures, including water supply systems, commonly handled by master plumbers.

New Public Works Bill in House Would Provide 2½ Billions

Sponsored by a group of labor and trade recovery interests, a $2,500,000,000 public works bill was introduced into the House, as H.R. 9696, by Representative Crowe of Indiana, May 21. The bill would provide $1,800,000,000 for non-federal public works, $525,000,000 for loan and grants for non-federal buildings and $175,000,000 for federal buildings. Relative to security to be required for loans, the bill states, "(b) It is hereby declared to be the policy of the Congress that this title shall be liberally construed, insofar as the requirement of security for loans is concerned, to the end that the Public Works program contemplated hereby shall be expedited to the fullest extent possible."

Chicago Sanitary District Submits Revised Plans to Supreme Court

At a meeting in Chicago of the legal representatives of the four lake states with Philip Harrington, chief engineer, and other officials of the Sanitary District of Chicago, PWA local officials and Col. Dan I. Sultan, representing the U. S. Engineers, the report of PWA board of review (*ENR*, May 17, 1934, p. 641) on the sewage treatment program was discussed. The lake states representatives would not put in writing any approval of the changes in order of procedure suggested by the PWA board but stated that they would enter no objections when the sanitary district filed a report and request with the Supreme Court to alter the scheduled program. In consequence such a report was filed May 15 and the request made the following day. If approval of the court is forthcoming, construction may be started late this season. If not, and the Court desires to investigate, a master would have to be appointed, hearings held, and a delay of upward of a year might result.

Opposition Develops Against Pending Federal Housing Act

Washington Correspondence

Strong opposition to the National Housing Act, now before the Senate banking committee, makes the fate of this measure very uncertain during the closing weeks of this session. The House seems disposed to put the bill off until February and the President is not inclined to press the matter unless there is demand. The United States Building & Loan League considers the bill a serious threat to its members. The league has a wide following in Congress.

Supporters of the bill took the position that if President Roosevelt wants the bill, it will go through. Cooperation of the American Bankers Association is pledged by Robert V. Fleming and state bankers associations will be lined up at numerous conventions during the next sixty days. Referring specifically to modernization Mr. Fleming said that credit machinery is workable and that volume of loans running full five years will not be large enough to cause bankers any difficulty. He regards modernization as desirable from every standpoint but believes a strenuous campaign is necessary to whip up response to overcome the opposition of the league. Witnesses scheduled to appear before the committee include Charles A. Miller, former president of the RFC, president Savings Banks Trust Co., New York; James H. Perkins, Chairman National City Bank; Orrin C. Lester, vice-president, Penn Mutual Life Insurance Co.; Lewis H. Brown, president, Johns-Manville Corp., and chairman of the housing subcommittee of the durable goods committee, W. Averill Harriman, NRA division administrator, and Leo T. Crowley, chairman, Federal Deposit Insurance Corp.

The league condemns the mortgage guarantee feature of the bill, declaring this will drive capital from the field, with resulting tremendous loss to government. The argument was offered that the 80 per cent guarantee during the depression would have cost the government several billions of dollars, and any guarantee provisions means that the government will have to take over all foreclosed real estate. The alternative that was proposed is the lifting of the bond limitations of the HOLC to purchase building and loan company shares. The league opposed the creation of federal mortgage associations. The sentiment among building and loan associations on the guarantee of deposits is divided but the league favors it, as the bank deposit guarantee is draining funds from associations.

The league endorses the modernization program but believes that the government would be underwriting a loss of $100,000,000, or 10 to 15 per cent of the loans. It recommends that the guarantee feature be limited to institutions which are subject to some public inspection and supervision.

Four More Dams to be Built by TVA in Tennessee Valley

The Tennessee Valley Authority, in a summary of the first year of its operation made public on May 18, has announced the location or tentative location of four dams its proposes to build in addition to the two dams now under construction.

The TVA engineering department is now making surveys and carrying on the preliminary work looking toward the construction of a run-of-river dam at Aurora on the Tennessee-Kentucky border, some 44 miles above the point where the Tennessee joins the Ohio, and at Pickwick Landing, in southeastern Tennessee, near the Mississippi-Alabama line. Similar studies are in progress for a storage dam on the Hiwassee River, which empties into the Tennessee above Chattanooga and for a storage dam somewhere on the French Broad River in the mountains of northeastern Tennessee.

The TVA now has under construction Norris Dam on the Clinch River near Knoxville, primarily for storage, and Wheeler Dam, 15½ miles above Wilson Dam, in Alabama, a combined power and navigation dam.

The proposed dam at Aurora Landing would develop a maximum head of 60 ft., but would be entirely drowned out at the time of high water in the Ohio River. Consequently a power plant at that site would be of little value in itself. However, when tied in to an integrated system such as the TVA proposes to build, its power would be of value because it can be produced in times of low flow in the river.

The pool formed behind the Aurora Landing dam will extend 163 miles up the river to the proposed dam at Pickwick Landing, and the dam at Pickwick Landing will form a pool extending upstream about 50 miles to a small dam known as Dam No. 1 near Florence, Ala. Above Dam No. 1 is Wilsons Dam (Muscle Shoals) and above Wilsons Dam is the General Joe Wheeler Dam, now under construction by the TVA. Consequently, with Aurora Landing and Pickwick Landing it will be possible to extend modern navigation facilities on the river about 360 miles to Guentersville, Ala.

Cove Creek Dam, the storage reservoir now under construction, is on the Clinch River on the west side of the Tennessee River drainage basin. The Hiwassee and the French Broad rivers are on the east side of the drainage basin where the rainfall characteristics are different from those in the Clinch River basin. Severel sites for storage reservoirs are available on the Hiwassee River, but the principal site on the French Broad is up in North Carolina near Asheville where land costs are high.

New York Multiple Dwelling Law Amended by Legislature

Eight bills passed by the New York legislature amending the multiple dwelling law of New York City have been signed by Governor Lehman. The more important changes provide for increasing the fire resistivity of existing tenements. Wireglass is required in doors and transoms opening into public halls. Stair fire escapes must replace the ladders now widely used. The necessary use of fireproof or fire retardant materials is also extended.

New Public Works Funds To Go to Non-Federal Projects

Appearing before the House appropriations committee, Secretary Ickes promised that he would not allot any additional public works funds, provided in the proposed bill, to Federal projects but would make all money available for non-Federal works on the previous 30 per cent grant-70 per cent loan basis. The administration bill is expected to provide $500,000,000 for public works, in addition to $100,000,000 for highway work. This assurance of the Secretary for a widespread distribution of the public works fund is in line with the desire of members of Congress.

Work Starts on $2,470,000 Project at Port Isabel, Texas

With the securing of necessary rights-of-way for the proposed ship channel from the turning basis at Port Isabel to the sub-port to be created four miles east of Brownsville, Texas, contracts will be let for dredging 18,000,000 yd. of material as the start of a $2,470,000 PWA project. The PWA financing will be secured by bonds of the Brownsville Navigation District.

Construction of the first unit of this deep-water port development program is already well advanced. It consists of the construction of jetties and the dredging of a ship channel from the Gulf of Mexico to the turning basin at Port Isabel. The formal opening of Port Isabel to ocean-going ships is scheduled for October, 1934.

Special Master Sets Valuation for Indianapolis Water Co.

Dismissal of the federal court suit of the Indianapolis Water Co. for an injunction to prevent enforcement of the present rate schedule was recommended on May 18 by Albert Ward, special master in chancery.

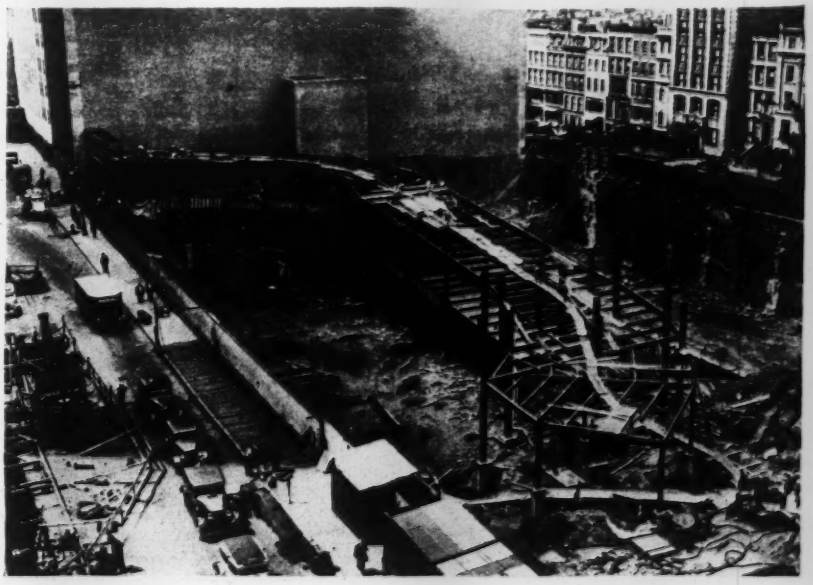
The recommendations placed a value of $20,282,143 on the company's property. The company had presented evidence to substantiate its claim to a valuation of $28,000,000. The city of Indianapolis had submitted evidence to support a $14,000,000 valuation. The valuation recommended in the special master's findings is $2,000,000 less than the sum set by the state public service commission.

In addition to recommending a lower valuation, Mr. Ward concluded that a 6 per cent return on the fair value of the water company's property would not be confiscatory. He stated that the return based on the present rates is 6.38 per cent.

The case was opened more than two years ago when the city and some consumers attacked the rates then in effect. A compromise rate was worked out at that time which reduced the hydrant-rental charges paid by the city, raised the rates for some large consumers and lowered the domestic rates. These rates were thereupon attacked by those whose rates had been raised and the public service commission ordered new rates, reducing the rates to large consumers to their former level and raising slightly rates for domestic rates. It was this schedule that the company attacked in its suit for an injunction.

LOWER-LEVEL TRUCKING ENTRANCE, ROCKEFELLER CENTER

The four-lane truck ramp, which will provide access from the street to the delivery and shipping level of the three-block Rockefeller Center development in New York City, is rapidly nearing completion. Located in the north block in the area recently excavated for future buildings, the ramp descends on a 9 per cent grade (7 per cent on the curve) to a depth of 34 ft., where it joins a subsurface roadway 32 ft. wide, with 13½-ft. headroom. The roadway extends 200 ft. east toward Fifth Ave. and then turns south into the lower level under the center block of the development, which is 320 ft. long and 185 ft. wide.



Bond Sale for Municipal Power Held Up by Court Action

The Missouri Utilities Co. has filed a suit in the circuit court at California, Mo., to restrain city officials and the state auditor from registering and issuing $100,000 in bonds to help finance construction of a municipal light and power plant and distribution system. The bonds were voted by the citizens of California on October 30, 1933, and the PWA has allotted a $155,000 grant and loan for the project. It had been planned to take bids late in May. Plans have been prepared by W. B. Rollins & Company, Kansas City, Mo.

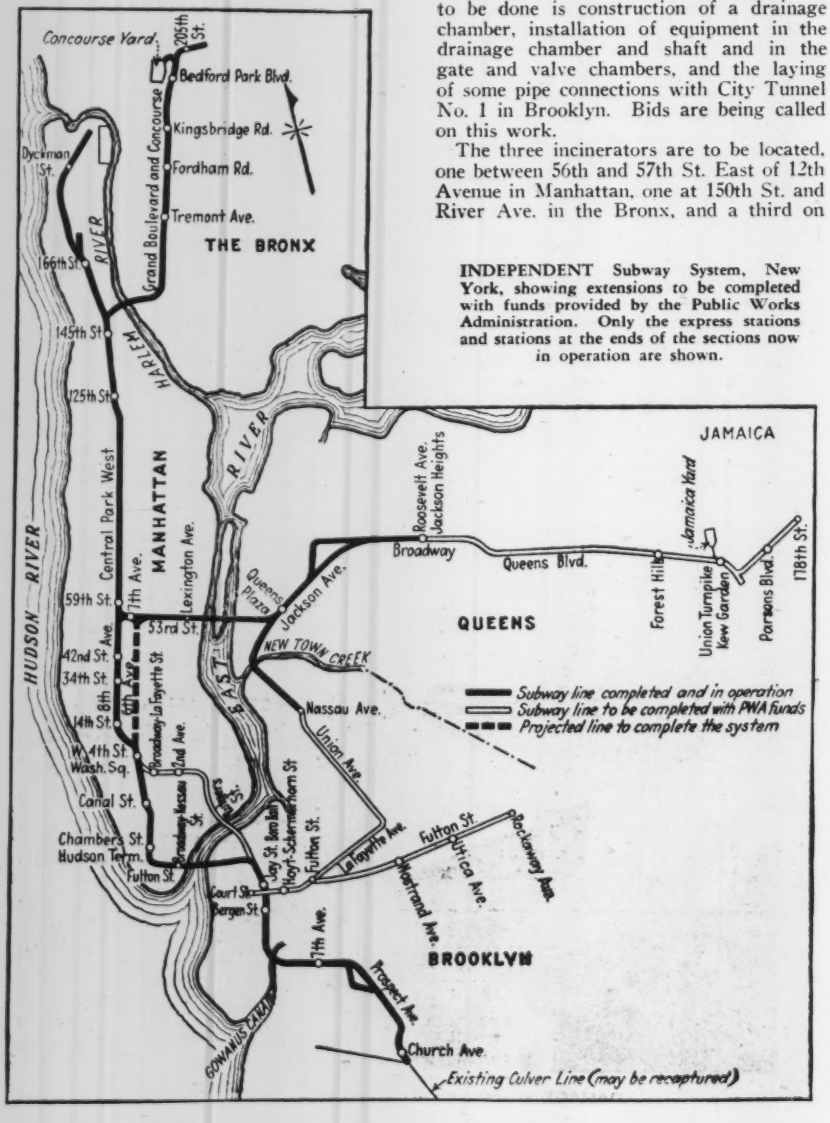
The Missouri Utilities Company has been furnishing electric power in California under a franchise awarded by the city and contends that its rates are satisfactory and reasonable. The petition contends that the proposed municipal plant will be an isolated project and not in accordance with conditions prescribed by the NRA with respect to desirability and engineering economy. The charge is also made that the contract with the PWA for a grant of $35,000 is void.

PWA Allots Funds To Complete Work On New York Subway

A COMBINED loan and grant totaling $23,160,000 to the city of New York for the completion of the unfinished sections of the Independent Subway System was approved by the Public Works Administration on May 16. Other allotments approved at the same time were $2,500,000 for the construction of a high school for 3,700 students at Bayside in the Borough of Queens; $2,268,500 for furnishing and equipping 17 school buildings; $4,000,000 for three incinerators; $800,000 for improvements at the Queens General Hospital and $1,000,000 to complete city water tunnel No. 2 of the Catskill Aqueduct System.

The driving of City Tunnel No. 2, a 20-mile tunnel extending from Hillview Reservoir in Yonkers through the Borough of Bronx and under the East River to Queens and into South Brooklyn, was completed in 1933. The work remaining to be done is construction of a drainage chamber, installation of equipment in the drainage chamber and shaft and in the gate and valve chambers, and the laying of some pipe connections with City Tunnel No. 1 in Brooklyn. Bids are being called on this work.

The three incinerators are to be located, one between 56th and 57th St. East of 12th Avenue in Manhattan, one at 150th St. and River Ave. in the Bronx, and a third on 31st Ave. between 130th and 131st streets in Flushing.



INDEPENDENT Subway System, New York, showing extensions to be completed with funds provided by the Public Works Administration. Only the express stations and stations at the ends of the sections now in operation are shown.

New York Appropriates Funds for Highway Bridges and Roads

An appropriation of $3,000,000 for the maintenance, repair, and reconstruction of state highways and highway bridges and a further appropriation of $2,000,000 for the maintenance of the county road system was made by the New York legislature during the recent session. The bill making funds available for maintenance and bridges on the state system, appropriates directly from the state treasury on vouchers approved by the superintendent of public works and the act takes effect immediately.

The second act, which provides the $2,000,000 for local roads, provides that the money shall be expended for the construction, reconstruction and maintenance of a county road system, including snow removal from county roads. During the year 1934 money appropriated by the state in accordance with this law is to be used entirely for maintenance and repair of county roads and bridges, but thereafter for two years it will be possible for counties to use up to 50 per cent of the allotment for paying installments and interest on bonds which the counties have issued to finance road construction.

Subway construction

The work covered by the $23,160,000 allotment to subway construction will complete the municipally-owned Independent Subway System as proposed in 1925 except for the Sixth Ave. line on which no work has been done as yet. All the other lines making up the system are either completed and in operation or complete except for track, station finish, signals, lighting and other equipment. The elements of the system are shown in the accompanying map. For simplicity, the other subway systems, those of the Interborough and of the Brooklyn-Manhattan Transit Co. are not shown.

The principal items covered by the allotment of PWA funds are as follows: Completion of the trackwork in the Rutgers Street tunnels, installation of track from Court Street to Rockaway Avenue and from Fulton St. to Nassau Ave., Brooklyn, and from Roosevelt Avenue in Jackson Heights to 178th St. in Jamaica, $2,295,000; special trackwork, ties, third rail, etc., $1,234,000; station finish, $2,238,000; station equipment and miscellaneous, $498,000; signals, $798,000; telephone and emergency alarm, $630,000; power equipment, $4,813,000; lighting, $1,027,000; drainage, $284,000; ventilation, $391,000; construction of the Stanton substation, $102,000; and inspection sheds in the Jamaica yard, $760,000.

The operations covered under these allotments will be advanced in orderly sequence, and it is expected that all of the lines will be ready for operation in 22 months.

The new work will add 18 route miles and 60 miles of track to the present operating system of 34 route miles and 110 miles of track.

A series of articles on the construction of this subway system was published in *Engineering News-Record*, Aug. 7, 1930, p. 200; Sept. 4, 1930, p. 371; Sept. 18, 1930, p. 455; Nov. 20, 1930, p. 796; Jan. 26, 1931, p. 136; Dec. 24, 1931, p. 1000; March 31, 1932, p. 471 and April 14, 1932, p. 546.

Dallas, Tex., to Make Improvements to Water Supply System

THE artesian source of water supply which now serves about one-third the population of Dallas, Texas, will be gradually replaced with a supply from surface sources, according to a policy recently adopted by the city water department. This change is necessitated by a serious decline in the artesian water level which will make this source uneconomical within a few years. The work to be done will involve the expenditure of about $135,000 (PWA grant has approval of state engineer) to provide a 24-in. main across the Trinity river and a 1,000,000 gal. storage tank. The change has been resisted by the residents of Oak Cliff, the western section of the city, who have been served artesian well water for many years.

Bids will be opened June 6 for the 24-in. main which will deliver the surface water from the main section of Dallas to the Oak Cliff section. Alternate bids have been asked for a steel conduit suspended from the Houston Street viaduct or a cast iron main to be placed underground. The 1,000,000 gal. storage tank to be built as part of the change in service will cost nearly $60,000. The Pittsburg-Des Moines Steel Co. was the low bidder for this work. The tank will be more than 100 ft. high and is believed to be larger than any similar tank in the Southwest. In addition to the river crossing and the tank, several new mains are required to provide the necessary connections to existing facilities.

The new facilities for the Oak Cliff section will be used for standby only for the present and the artesian water will be used as long as it lasts. A recent survey by A. P. Rollins, consulting engineer, Dallas, Tex., indicated that the cost of the artesian supply is 0.0563 cents per 1000 gallons as compared to 0.0240 cents for the filtered surface supply. The report esimates that the city could save about $47,000 per year by closing the artesian wells. In addition, the report indicates that the filtered surface water would be superior in the matter of solids and bacteriological contamination.

Source of supply

The increased demand for surface water will be supplied from Lake Dallas, the reservoir about 25 miles north of the city on a fork of the Trinity river. The water department has an applicaion for a PWA loan pending and if this is granted, plans to spend about $800,000 on improvements at the reservoir. Revenues of the water department would be used for securing the loan. The reservoir improvement program would include doubling the capacity of the present filtration plant and spending about $500,000 for rebuilding and replacing mains.

New York Charter Amended To Provide for Sewage Plants

On May 8 Governor Lehman signed a bill amending the charter of New York City so as to provide for the erection of sewage treatment plants, including intercepting sewers, grit chambers, sewerage tunnels and other incidental construction, through the use of PWA funds. The act provides for the issuance of special assessment bonds having a term of not more than thirty years.

The act provides that the cost of construction shall be borne by the city of New York as a whole and shall be collected with the taxes upon real property in annual installments over a period of not more than 20 years. The proceeds from the sale of the special assessment bonds shall be paid into a special account and used exclusively for sewage plant construction purposes. Assessments when collected shall also be paid into a special fund and set aside and used exclusively for the redemption of the bonds.

This legislative enactment paves the way for the city's utilizing an allotment by the PWA for the completion of the Wards Island sewage plant.

New York Canal Improvement Authorized by State Law

Improvement of the New York barge canal, particularly the section from Waterford, its junction with the Hudson River, to Lake Ontario at Oswego, is authorized by a bill passed by the New York legislature. Efforts will be made to secure federal financing for this improvement. The bill provides for an initial appropriation of $10,000,000 by the state which would be reimbursed by federal funds. The work would consist of deepening the canal to 14 ft., widening and straightening the alignment and raising the overhead clearance at bridge crossings to uniform height of 30 ft. At present there are numerous low bridges over the canal.

Chicago Fire Damages Elevated Railway—Low-Cost Housing Suggested For Area

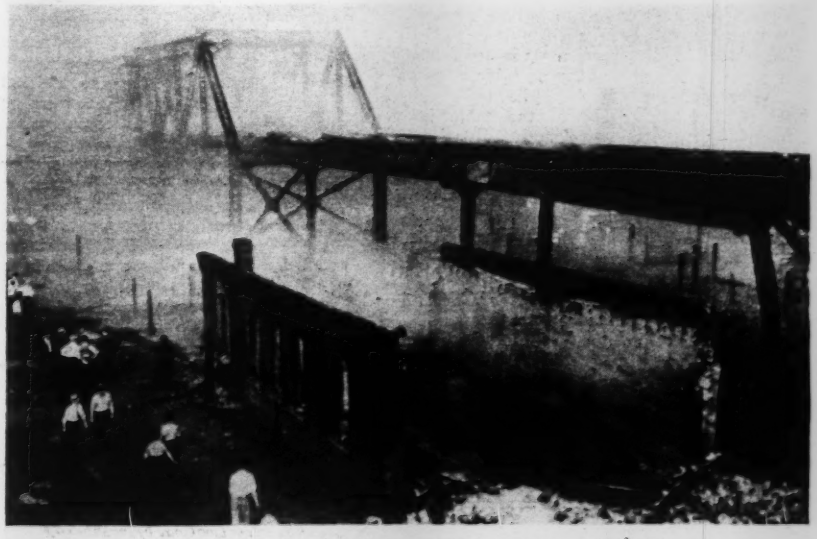
Damage to the Chicago elevated railway estimated at more than $100,000 resulted from the fire which swept through 60 acres of the stock yard section of that city May 19. At the Halstead Street Station the platform and ties for about 1,500 ft. were burned. Rails and girders for a distance of about 400 ft. and one double bent support were badly warped and twisted beyond repair. One car was burned. Sparks ignited ties at the curve from Exchange into Union Ave. and burned 200 ft. but this section was repaired and traffic resumed on Sunday night on the shuttle service between Indiana and Halstead Streets.

Because of the lease arrangements with the Chicago Junction Railroad, west of Halstead Street, repairs on this section will be delayed until legal phases have been adjusted. Two bridges over Chicago Junction Railway, first thought to be destroyed, are now believed to be available for use by realigning. The entire damage to the elevated system is estimated at between $100,000 and $150,000.

The conflagration swept over an area of about 60 acres of the Chicago stock yards, starting in the cattle pens. It burned over 40 per cent of the wooden cattle pens and chutes. The fire destroyed International Livestock Amphitheatre, the nine-story Exchange Building, the Drovers Journal Building and several smaller structures. The interior of two banks, the famous Saddle and Sirloin Club and the Stockyards Inn were badly damaged. Along Halstead Street, for three blocks, the low-grade stores with upstairs apartments were burned.

Low cost housing suggested

A survey of the Chicago fire area has been ordered by Administrator Ickes to determine the feasibility of using this section for a low-cost housing project. Horatio B. Hackette, general manager, PWA Emergency Housing Corporation, left Washington May 22 to inspect the area and confer with Mayor Kelly and others. Secretary Ickes said that the land values and other circumstances presented by this situation might make housing development inadvisable but it is rare that such a metropolitan section, in a district which needs improved housing so badly, becomes available without the necessity of tearing down existing improvements.



DAMAGE to elevated railway exceeds $100,000 in Chicago fire

Record Dust Storm Emphasizes Soil Erosion Problem

The record dust storm of May 9-11 which originated in the drought-stricken states of the upper Mississippi Valley and produced a thick yellow cloud that crossed to the eastern coast, tended to emphasize the general soil erosion problem, now being studied by the federal government. Extending for a distance of about 1,000 miles in a north and south direction and 1,500 miles from east to west, according to estimates, the cloud deposited dust and obscured the sun in many of the metropolitan areas on the east coast. The storm is considered to be the most extensive ever occurring in this country, according to a report of H. H. Bennett, director of the Soil Erosion Service, but has been preceded by lesser storms in the Southwest, during the past two years of deficient precipitation.

Late in 1932 serious dust storms occurred in the Texas and Oklahoma panhandle area and adjacent sections of Kansas and Colorado. As the drought of that year continued, this wind erosion effect spread to a wider area. In April, 1933, soil material of red character from parts of Oklahoma and Texas was moved by the wind in sufficient quantity to produce a reddish color on the dark soils of Iowa. The fall rains of 1933 tended to relieve this situation but the wind erosion began again early in 1934 with the deficiency in spring rains. Storms have continued for the past two months in almost uninterrupted succession over parts of the area west of the Mississippi River, increasing in size and severity.

During the past two decades the acceleration of wind erosion on the Great Plains region, following the breaking up of the natural grass cover, has been mentioned repeatedly in technical reports.

Disbursements for PWA Projects Reach $377,275,000 by May 1

Actual disbursements for construction from the $3,300,000,000 public works fund, other than expenditures for the CWA, TVA, and CCC, had reached only $377,275,000 by the end of April, according to the records of the Public Works Administration, although over two billion dollars has been allocated to such work. The allotments and disbursements to April 30 are given in the accompanying table.

The remainder of the $3,300,000,000 fund not accounted for in the table is covered by the executive and legislative allotments, chiefly the Emergency Conservation Corps, Civil Works Administration, Farm Credit Administration, Emergency Housing Corp., Tennessee Valley Authority, Subsistence Homesteads, and administration of the NRA and PWA. Some expenditures for construction such as those of the TVA and the CWA, therefore, have been made from the public works funds in addition to those given in the table.

	Allotments	Disbursements
Non-federal	$778,592,000	$98,350,000
Federal	1,381,867,000	278,925,000
Total	$2,160,459,000	$377,275,000
Non-federal allotments		Non-federal disbursements
State and municipal	$541,357,000	$63,289,000
Limited-dividend housing	23,130,000	686,000
Railroads	199,608,000	33,398,000
Private and Misc.	14,497,000	977,000
Total	$778,592,000	$98,350,000

Bridge Competition Awards Announced by Steel Institute

First prize in the sixth annual bridge design competition sponsored by the American Institute of Steel Construction was awarded K. R. Darrah of Rensselaer Polytechnic Institute, Troy, N. Y. The second prize was won by George Pistey, a student in the same institution. The three honorable mentions were awarded to David Hiat, New York University, J. F. Nowak, Rensselaer Polytechnic Institute, and Albert R. Nozaki, University of Illinois, in the order named.

The problem, this year, was to design a steel tower for a small highway suspension bridge. In addition to certificates of award, the first and second prizes this year carried a cash compensation of $100 and $50, respectively. The awards were made from the ten best designs selected in a preliminary competition when sixty-two students from twenty-four colleges in the United States entered drawings. The jury of award this year consisted of D. B. Steinman, and Leon S. Mosseiff, consulting engineers of New York, H. Van Buren Magonigle, and H. T. Lindeberg, architects, New York, and B. F. Betts, Editor, *American Architect*.

Louisiana Counties May Demand Legal Share of State Gas Tax

A resolution adopted by the Iberville Parish (County) governing authority, suggests the joining of the other counties of Louisiana in a suit to compel the highway commission to set aside immediately and expend a total of $21,000,000 for local roads which, the resolution alleges, is required to be used from the state gas tax revenue for the purpose.

The resolution refers to subdivision E of paragraph 22 of Article 6 of the State Constitution, as amended November 4, 1930, providing that $7,000,000 shall be set aside annually during the years 1931-1934 and used exclusively for gravel, shell and crushed rock county roads and local bridges to be distributed in proportion to the mileage of unimproved roads within the county (parish). The resolution further requests that the Commission carry out the terms of this provision of law by immediately setting aside $21,000,000 for the 1931-33 biennial and urges other local governing bodies to join in a suit to compel such action.

New Orleans recently won a similar mandamus suit requiring the commission to pay $175,000 from gas tax revenue for maintenance of the city streets. The suit, covering the last quarter of 1933, was taken successfully to the Louisiana supreme court, and the succeeding quarterly installment is already covered by a favorable decision recently secured in the district court.

SOCIETY CALENDAR

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting at Cornell University, Ithaca, N. Y.; conferences, June 19-21, regular meetings June 21-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, spring meeting, Jamestown, N. Y., June 15-16.

METROPOLITAN SECTION, American Society of Civil Engineers, held its annual meeting in New York on May 16. New officers elected were: President, Ole Singstad, consulting tunnel engineer, Port of New York Authority; vice-president, Enoch R. Needles; directors, J. L. Leonard, H. W. Hudson and S. K. Finch. Wm. J. Shea was re-elected secretary. Armin H. Lobeck, professor of geology at Columbia University, spoke to the section on climatology. A special feature of the meeting was a speaking contest put on by the Junior Branch of the section. The secretary reported that during the year the section had contributed $1,250 to the administrative expenses of the Professional Engineers Committee on Unemployment.

CCC Work to be Expanded in Tennessee Valley Area

Five Civilian Conservation Corps camps will be located on state park projects of the TVA this summer and 23 other CCC camps will be located in the Tennessee Valley area. At the new town site of Norris the CCC work in the park development will consist of providing a small lake for bathing facilities, building a recreation hall, lodge and cabins, seven acres of tree planting and 700 acres of forest control.

Personals

MAJOR B. B. SOMERVELL, formerly division engineer, Corps of Engineers, Memphis, Tenn., has returned to this country from an assignment in Turkey and is at present stationed in the office of the Chief of Engineers. Major Somervell worked with other officials of the United States Government in the making of a general economic survey of Turkey.

WALTER FLEMING, who has been connected with the bridge office of the Ohio state highway department, has been appointed assistant division engineer in charge of bridges for highway division 11.

GEORGE E. STUART, head of the street department of Newton, Mass., has announced his retirement from active service Aug. 1. Mr. Stuart has been in the employ of the city for 55 years, and since reaching his 70th birthday in 1927 has been annually reappointed to his present position. He is a charter member of the Massachusetts Highway Association.

JOSEPH G. SHRYOCK, chief engineer, Belmont Iron Works, Philadelphia, Pa., has just been awarded a certificate of merit by the Franklin Institute of Philadelphia "for his ingenious combination of standard structural shapes in the formation of a light bridge floor" referred to as an interlocking channel deck.

Obituary

CASS GILBERT, well known American architect, died suddenly in England on May 17 at the age of 74. His name is always associated with the design of the Woolworth building in New York City.

WILLIAM J. DONOVAN, construction engineer for the Turner Construction Co., Boston, Mass., died in that city May 18 at the age of 36.

JOSEPH J. HOCK, 54 years old, president of the Arundel Corp., Baltimore, died in that city May 15. Mr. Hock succeeded the late Frank A. Furst as president of the company in 1922 when Mr. Furst became chairman of the board. Mr. Furst died in January of this year. Mr. Hock had been associated with Mr. Furst for many years.

ANDREW YOUNG, for many years prominently identified with the development of Los Angeles harbor, died May 10 at Wilmington, Calif., at the age of 84. Mr. Young was consulting engineer for the old Wilmington Transportation Co.

TIMOTHY W. BRESNAN, head of the contracting firm of T. Bresnan & Sons, Baltimore, Md., died at his home May 14 at the age of 76. Mr. Bresnan was the last survivor of a group of men who organized the Baltimore Wrecking and Contracting Co. in 1914, which did a large part of the work involved in clearing away the ruins of the Baltimore fire.

LEONARD J. FARRELL, chief engineer of the Public Service Co. of New Hampshire since 1897, died suddenly in Manchester May 14 at the age of 73. He served for many years as a member of the Manchester Highway Commission.

LORENZO DANA CORNISH, until July 15 chief engineer Illinois State Division of Waterways, died May 12 in Chicago at the age of 57. He was born in Lee Center, N. Y., and was graduated in 1902 from Syracuse University in civil engineering. In 1906 and 1907 he was assistant engineer of the Isthmian Canal Commission, later going to Panama for six years in charge of design and lock inspection. He served as captain in the Engineers Corps in the A.E.F. and was promoted to major. Immediately after his war service in 1919 he joined the staff of the Illinois Waterway Division serving consecutively as designing engineer, assistant chief engineer, and in 1928 was made chief engineer.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING AWARDS for this week at $20,027,000 are 15 per cent below the average week to date. The drop is in state and municipal work which totals only $11,886,000 for the week while federal work at $5,285,000 is 145 per cent higher than last week and slightly over the average week to date. Private awards at $2,856,000 are ahead of last week but 60 per cent below the average week to date.

The drop in public work is in highways and bridges. Street and road awards for the week total only $5,115,000 and bridges $620,000. Public buildings are higher this week $5,145,000 as are sewerage contracts at $1,478,000. Earthwork, drainage and irrigation are also up to $3,230,000.

Large awards for the week include the state hospital at Waltham, Mass., $501,000; equipment for the state hospital at Manteno, Ill., $872,000; the north ward building for Homer G. Phillips hospital, St. Louis, $516,000; camp buildings for Fort Peck dam, Mont., $740,000; the north and south side sewers, Peoria, Ill., $1,022,000; and dredging Monroe Harbor and placing rip rap, Michigan, $725,000.

Sales of state and municipal bond issues for new productive purposes increased this week to the third highest week of this year, $9,752,000. These include the Houston, Texas, financing $1,112,000 for drainage, street improvements, water works, bridges, parks, subway and general improvements; the water works issue, $2,000,000 sold by Los Angeles; school and sewer bonds sold by Newton, Mass., $675,000; sewage disposal plant bonds by Minneapolis, $1,100,000; and water distribution bonds sold by San Francisco, $1,324,000. The St. Louis, Mo., municipal bond issue election carried providing for $16,100,000 financing for public improvements and $2,000,000 in school bonds.

CONTRACTS

(Thousands of Dollars)

	Weekly May 1933	Average Prev. 4 Weeks	Week May 24 1934
Federal Government	$751	$2,774	$5,285
State and municipal	14,360	15,782	11,886
Total public	$15,111	$18,556	$17,171
Total private	4,438	4,482	2,856
Week's total	$19,549	$23,038	$20,027
Cumulative to date:			
1933	$341,430	1934	$492,432

NEW PRODUCTIVE CAPITAL

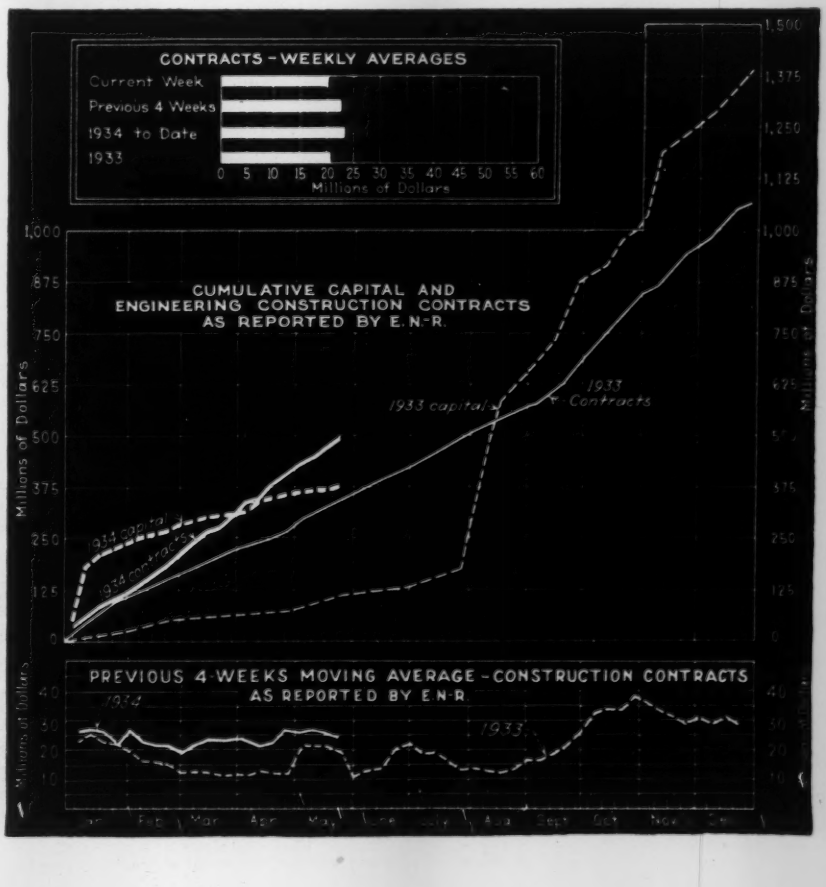
(Thousands of Dollars)

1934	Week May 24	Cumulative
State and municipal	$9,752	$125,961
PWA allotments, S&M	....	186,837
Corporate issue	14	13,989
PWA allotments, private	....	50,417
Total, Non-Federal	$9,766	$377,204
PWA allotments Federal Constr.	....	49,436
Total new capital	$9,766	$426,640
Cumulative to date:		
1933	$114,368	1934	$377,204
Rescinded or reduced allotments (from 1933 PWA totals)		$43,323

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

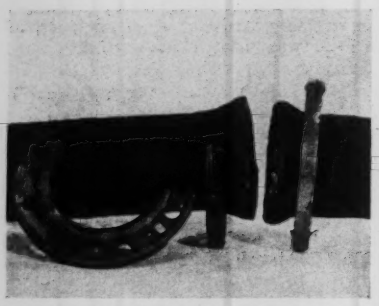
E.N.-R.-Cost		E.N.-R.-Volume	
May, 1934	199.61	April, 1934	109
April, 1934	195.86	March, 1934	108
May, 1933	164.39	April, 1933	65
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1934 to Date
1933
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1933 capital
1933 Contracts
1934 capital
1934 contracts
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

New Joint for Rubber Hose

A new hose joint which eliminates all contact between metal and fluid has recently been patented by the B. F. Goodrich Rubber Co. The new joint, designated "Flexseal," is designed particularly as a substitute for nipples and flanges. It is recommended particularly for the larger diameters of suction or discharge hose handling abrasive materials and hose handling acid or other corrosive liquids.



"Flexseal" joint for rubber hose

The success of the joint is dependent on the special end which is built into the hose. This end consists of an enlargement, or head, reinforced with numerous plies of fabric surrounding a rigid steel ring of angular cross section. The joint is assembled with the aid of split flanges and standard bolts. Two successive lengths of hose can thus be bolted together with the rubber ends of the hose compressed to form a seal.

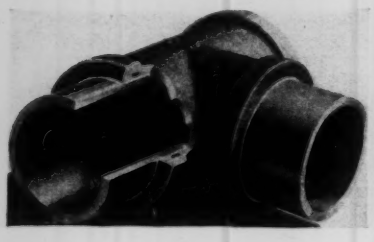
The joints are furnished in sizes from 1½ in. up.

Threadless Bronze-Pipe Fitting Comes Provided with Solder

A new type of threadless bronze pipe fitting has been announced by the Walworth Co., New York, N. Y. It incorporates in each opening of the fitting a ring of brazing alloy, known as Sil-Fos. The job of installing consists of slipping the pipe into the fittings, then applying an oxyacetylene flame in the proper manner until a white ring appears.

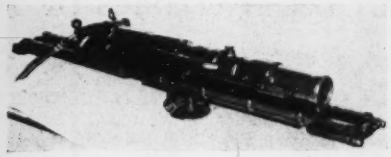
The Sil-Fos flows out beween the fitting and the pipe in both directions from the ring. The proper quantity of brazing alloy is included in each outlet and there can be no clogging of the line due to an excess. Should it be necessary to remove the fitting it can be used again by repeating the operation employed in making the original joint because there is sufficient brazing material to make two complete joints.

New Walworth fitting for bronze pipe



Self-Feeding Drifter Drill

A new self-feeding drifter drill capable of high speed has been announced by the Gardner-Denver Co., Quincy, Ill. The new drill is designated "Selfeed" and is vibrationless, with a self-controlled positive action. The rate of feed is in adjustment with the speed with which the drill cuts into the rock, this synchronized action keeping the machine from feeding too fast or too slow. The drill is thereby held constantly in proper striking position.



"Selfeed" drifter drill announced by Gardner-Denver

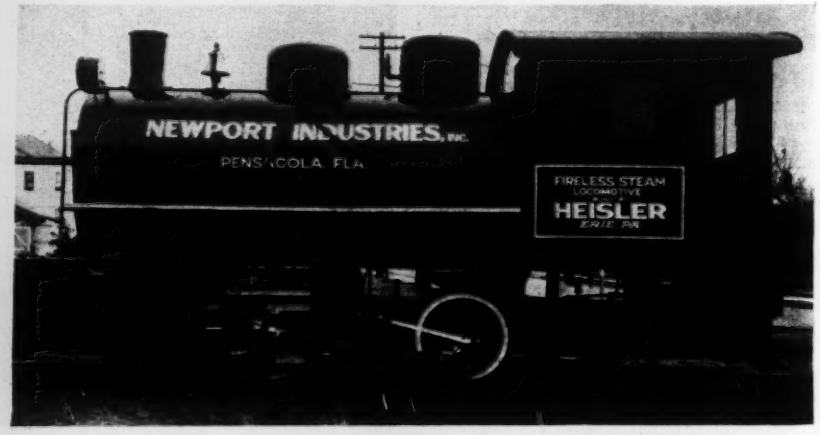
Special Locomotive Uses No Fuel

A locomotive that burns no fuel, operating with a periodically replenished charge of steam, has recently been built by the Heisler Locomotive Works, Erie, Pa., for an operation in Florida. In place of a boiler, the engine has a tank of welded construction with a capacity of about three times that of an ordinary locomotive boiler. This tank, which is heavily lagged and jacketed to prevent loss of heat, is filled with water to about four-fifths its capacity. Then, by a steam pipe run from a stationary boiler to a point below the level of the water in the tank, the water is heated until the pressure and temperature in the locomotive tank are the same as in the stationary boiler from which the charge is being taken. It is from this heat stored in the water that the locomotive gets its power.

As the steam is drawn off, the pressure and temperature of the steam remaining above the water in the tank are reduced. During this reduction part of the water is turned into more steam, and this process continues until atmospheric pressure is reached.

The engine can be charged from any stationary boiler which carries a pressure of 100 lb. or more. One charge may last from two to ten hours under normal conditions of service. From 10 to 30 minutes is the usual time required for charging.

Locomotive built by Heisler Locomotive Works. It operates with a periodically replenished supply of steam



New Equipment in Brief

Tractors. The "22" tractor has recently been announced by the Caterpillar Tractor Co., Peoria, Ill. It is provided with a 4-cylinder engine developing 23.7 drawbar horsepower at 1,250 r.p.m.

Hard-Surfacing Electrode. A new shielded-arc electrode for building up steel surfaces to resist shock and abrasion, called "Wearweld," has been announced by the Lincoln Electric Co., Cleveland, Ohio. Deposits made with this electrode are air hardening alloy steel with an unusual combination of hardness and toughness, according to the manufacturer. Wearweld can be used to build up all steels other than those of the austenitic type. A single layer of the material on mild steel has a hardness of 40 to 45 Rockwell C. Additional layers will have a hardness of 48 to 52 Rockwell C, it is claimed.

Business Notes

C. R. MESSINGER, chairman of the board of the Chain Belt Co., Milwaukee, Wis., has resumed the post of president of the company, left vacant by the sudden death of his brother, Clifford F. Messinger, in December. For the past three years Mr. C. R. Messinger has been president of the Oliver Farm Equipment Co. and was recently elected chairman of the Oliver Board.

WESTERN WHEELED SCRAPER COMPANY, Aurora, Ill., and Austin Manufacturing Company, Chicago and Harvey, Ill., have consolidated under the name Western-Austin Manufacturing Company. For some years the Austin-Western Road Machinery Co. has marketed the equipment made by both organizations and will continue to handle the sales of the consolidated company.